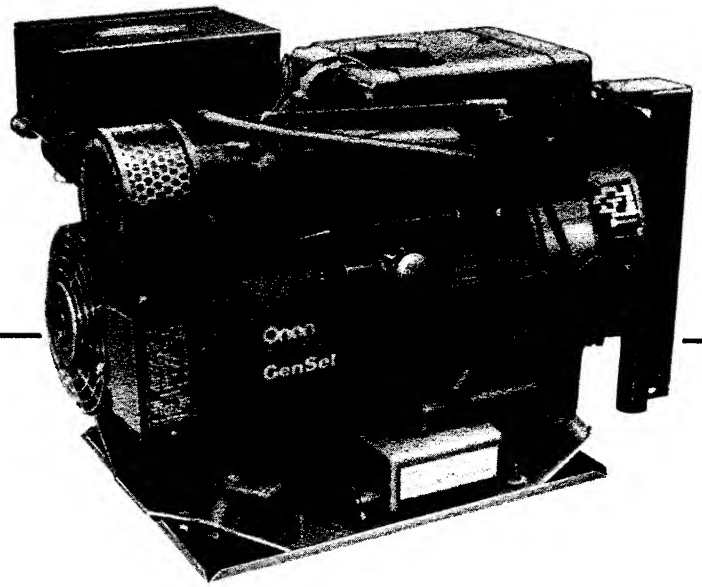
Onan

Service Manual

AJ

GenSet



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Safety Precautions

Read the Operator's Manual before operating the generator set. Proper maintenance, operation, and service are essential for safe and efficient operation. Many accidents are caused by failure to follow fundamental rules and precautions. The following symbols are found throughout this manual. They alert you to conditions that are potentially dangerous to the operator, service person or the equipment.

⚠DANGER ***This symbol alerts you to an immediate hazard that could cause severe personal injury or death.***

⚠WARNING ***This symbol alerts you to a hazard or unsafe practice that could lead to severe personal injury or death.***

⚠CAUTION ***This symbol alerts you to a hazard or unsafe practice that could lead to personal injury or damage to the equipment or property.***

FUEL GAS AND GASOLINE ARE HIGHLY FLAMMABLE AND EXPLOSIVE

- Do not fill the fuel tank while the engine is running, unless the tank is outside the generator room or compartment. Hot engine parts can ignite the fuel.
- Do not smoke or use an open flame near the generator set or fuel tank.
- Make sure that fuel lines don't leak and that they are adequately supported. Fuel connections at the engine should be made with an approved flexible, non-conductive fuel line. Do not use copper tubing as a flexible connection. Copper may crack due to work hardening.
- Install an approved fuel shutoff valve in the supply line.

EXHAUST GAS IS DEADLY!

- Exhaust gas must be discharged to the out-of-doors. Make sure that the exhaust system is adequate and does not leak.
- Exhaust gas or heat from the engine must never be used to heat a room or other enclosed space.
- Never sleep in a vehicle with the generator set running, unless the vehicle is equipped with a carbon monoxide detector that is working.

HIGH VOLTAGE IS DEADLY!

- Use extreme caution when working on electrical equipment.
- Use dry wooden platforms insulated with rubber mats to cover metal or concrete floors when working on electrical equipment.
- Make sure your hands and clothes, especially shoes, are dry when handling electrical equipment.
- Remove jewelry, which is highly conductive, before handling electrical equipment.
- The installation must meet state and local electrical codes and be performed by a licensed electrician.
- DO NOT CONNECT THE GENERATOR SET DIRECTLY TO ANY BUILDING SYSTEM. Electrocution and damage to the equipment and property could result from the high voltages that can build up if the generator set is connected with the utility line. Connections must be through an approved device. Before making connections, make sure the main building service switch is off, and that it is tagged to prevent it from being turned on accidentally. Consult an electrician regarding emergency power use.

FAN BLADES CAN CAUSE INJURY

- Keep hands away from the engine and generator cooling fans and keep the guards in place.

THE MUFFLER AND EXHAUST PIPE GET HOT

- Use caution when making adjustments with the set running.

GENERAL SAFETY PRECAUTIONS

- Have a fire extinguisher handy. Maintain it properly and know how to use it. Extinguishers rated ABC by the NFPA are suitable. Consult the local fire department about the suitability of other types.
- Do not let grease, oil and dirt accumulate on the set. A dirty engine can run hot and be damaged or cause a fire.
- Do not use the generator compartment for storage. Oily rags, gas cans, propane cylinders, wooden blocks, etc. can ignite or explode or interfere with cooling and ventilation. Keep the compartment floor clean and dry.
- Do not smoke near batteries. When disconnecting a battery, first disconnect the negative (-) battery cable at the set to keep sparks as far away as possible from the battery. Lead acid batteries emit highly explosive hydrogen gas that is easily ignited by smoking or sparks.
- Do not operate or service the set when tired or after having consumed drugs or alcohol.

Table of Contents

Section 1. Introduction

ABOUT THIS MANUAL

This manual provides service information for the series AJ generator sets. This service manual is for the experienced service person. It covers troubleshooting, disassembly, repair, reassembly and adjustments for the engine and generator. It is recommended that the service person be thoroughly familiar with the principles of gasoline engine operation and have a basic knowledge of electrical fundamentals. Other Onan publications, such as Electrical/Mechanical Fundamentals (932-0408), Onan Generator Training Manual (932-0408) and the Operator's Manual (924-0121 or 924-0122), are recommended as additional sources of information.

Read all service procedures completely before beginning any repair work and observe all cautions and warnings. The installation must comply with local codes.

The most critical areas of concern include the exhaust system, fuel system, electrical wiring and ventilation. Faulty installation, maintenance or service can lead to severe injury or death or damage to the equipment or property.

MODEL IDENTIFICATION

When contacting an Onan Dealer or Distributor, always supply the complete Model Number and Serial Number as shown on the nameplate of the set (Figure 1-1). This information is necessary to identify the set when ordering replacement parts.

Always use genuine Onan replacement parts obtained from an authorized Onan Dealer or Distributor. Universal replacement parts (usually intended for automotive use) often look similar but might not perform to Onan specifications. Only genuine Onan replacement parts are designed and tested for this equipment.

⚠WARNING ***Faulty service or replacement of parts can lead to severe injury or death or damage to the equipment or property. Service must be done by qualified persons.***

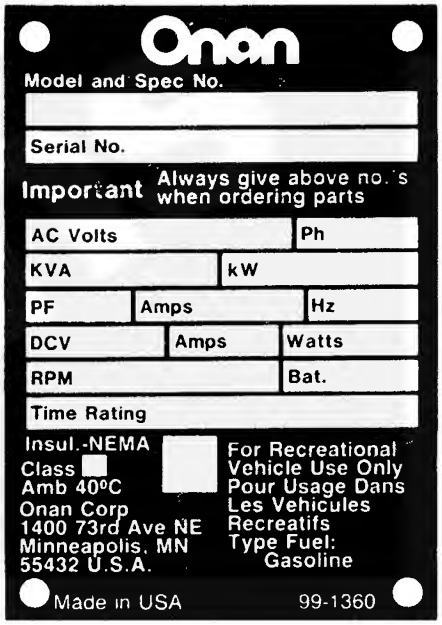

FIGURE 1-1. ONAN NAMEPLATE


cummins

Section 2. Specifications

BASIC CONFIGURATIONS AND APPROXIMATE WEIGHTS

Standard Models

Portable, manual start	140 pounds (64 kg)
Stationary, manual or remote electric start	180 pounds (82 kg)
Battery Charger, remote electric start	180 pounds (82 kg)
Fire Department, electric start at set	180 pounds (82 kg)

Recreational Vehicle (RV) Models

Remote electric start	160 pounds (73 kg)

ENGINE DETAILS

Design	4-stroke gasoline, single cylinder, air cooled, L-head
Displacement	14.9 inches^3 (244 cm^3)
Compression Ratio	
Gasoline fuel	6.25
Gas fuel	7.1
Cylinder bore	2-3/4 inches (70 mm)
Piston stroke	2-1/2 inches (64 mm)
Oil Capacity	
Portable models	2.5 pints (1.2 litres)
Stationary models	3.5 pints (1.7 litres)
RV models	2 quarts (1.9 litres)
Fuel	
All models	gasoline
Stationary models	may be equiped for LP vapor or Nat. gas fuels
Cooling	centrifugal blower in pressure or Vacu-flo configurations
Starting Battery Requirements	
Stationary models	12 V, 105 amp/hr (378 kC)
RV models	12 V, 92 amp/hr (331 kC)
Ignition System	
Standard models	magneto
RV models	battery
Governor	internal flyball, externally adjustable to +/- 5% of rated speed

GENERATOR DETAILS

Design

Revolving armature, self excited, inherently regulated to +/- 10% rated voltage at rated speed, self limiting, single phase, unity power factor, 2-pole (except 1800 RPM models, which are 4-pole).

Styles

Standard (all models except RV) - Manual start models use rectifiers in the excitation current circuit and electric start models the commutator. The generator is motorized for starting electric start models. A centifugal blower is provided for cooling.

RV - The generator is motorized for starting and the commutator is used in the excitation current circuit. The generator is cooled by the engine vacu-flo blower.

Ratings

STYLE	WATTS	AC VOLTS	HERTZ/RPM	AC WIRES
Standard	1000	120 or 240	60/1800	2
Standard	2000	120	50/3000	2
Standard	2000	120/240	50/3000	3
Standard	2500	120	60/3600	2
Standard	1500	24 DC	-/2400	-
Standard	1500	32 DC	-/2400	-
RV	2500	120	50/3000	2
RV	2500	120/240	50/3000	3
RV	3000	120	60/3600	2

TUNE UP SPECS

Spark Gap

Gasoline Fuel ..... .025 inches (.64 mm)
Gas Fuel and Combination Fuel ..... .018 inches (.46 mm)

Ignition Timing

1800 RPM Models ..... 19° BTC
Standard Models ..... 25° BTC
RV Models ..... 22° BTC (non-adjustable)

Breaker Point Gap

Magneto Ignition ..... .022 inches (.56 mm)
Battery Igniton ..... .022 inches (.56 mm)

Flicker Point Gap

1800 RPM Models Only ..... .020 inches (.51 mm)

Valve Clearance (Engine Cold)

Intake ..... .011 inches (.28 mm)
Exhaust ..... .011 inches (.28 mm)

Section 3. Dimensions and Clearances

	Inches	Millimeters
Standard cylinder bore (Includes piston clearance) (Maximum .003 inch [0.8 mm] out-of-roundness and .005 inch [.13 mm] taper allowable)	2.7525-2.7535	69.914-69.939
Standard piston diameter (0.005, 0.010, 0.020, 0.030 and 0.040 inch oversizes available)	2.747-2.748	69.77-69.80
Piston ring gap in cylinder (0.010, 0.020, 0.030, and 0.040 inch oversizes available)	0.006-0.024	0.15-0.61
#1 (top) piston ring groove width	0.0955-0.0965	2.43-2.51
#2 piston ring groove width	0.0950-0.0960	2.41-2.4
#3 piston ring groove width	0.1565-0.1575	3.98-4.44
#1 piston ring side clearance	0.002-0.008	0.05-0.20
Piston pin diameter	0.6250-0.6252	15.875-15.880
Piston pin to connecting rod clearance	Thumb push fit	
Piston pin to piston clearance	Hand push fit	
Standard crankshaft main journal	1.6857-1.6865	42.817-42.837
Standard main journal bearing (0.002, 0.010, 0.020 and 0.030 inch undersizes available)	1.688-1.690	42.875-42.926
Crankshaft end play	0.008-0.012	0.2-0.3
Standard crankshaft rod journal	1.3742-1.3750	34.905-34.925
Rod to crank journal clearance (0.010, 0.020 and 0.030 inch undersize rod bores available)	0.0015-0.0025	0.038-0.064
Connecting rod side clearance	0.012-0.035	0.3-0.9
Camshaft journal	1.3740-1.3745	34.900-34.912
Camshaft journal bearing	1.376-1.377	34.95-34.98
Camshaft end play	0.003	0.076

Section 3. Dimensions and Clearances (continued)

	Inches	Millimeters
Intake valve stem	0.3080-0.3085	7.823-7.836
Exhaust valve stem	0.3090-0.3100	7.885-7.874
Valve guide (intake and exhaust)	0.3110-0.3120	7.900-7.925
Valve face angle (intake and exhaust)	44	
Valve seat angle	45	
Minimum valve edge width	1/16	2
Valve seat width	1/32-3/64	0.8-1.0
Standard valve seat bore (exhaust)	1.063-10.64	27.00-27.03
Standard valve seat diameter (exhaust) (0.002, 0.005, 0.010 and 0.025 inch oversizes available)	1.067-1.068	
Valve tappet diameter	0.7475-0.7480	18.987-19.000
Valve tappet bore	0.7505-0.7515	19.063-19.088
Approximate valve spring free length	1.6	41
Valve spring length (valve open)	1.31	3.33
Valve spring tension (valve open)	71-79 pounds	32-36 kg

Section 4. Torque Specifications

Torque Specifications	Foot-Pounds	Newton-Meters
Cylinder head (cold)	24-26	33-35
Connecting rod	10-12	14-16
Rear bearing plate (cast iron)	20-25	27-34
Rear bearing plate (aluminum)	15-20	21-27
Flywheel mounting screw	35-40	48-54
Oil base	25-30	34-40
Gearcase cover	10-15	14-18
Spark plug	18-20	24-27
Oil plug	7-9	10-12
Fuel pump	7-9	10-12
Rotor through bolt	25-30	34-40
Generator mounting bolts	12-15	16-20
Carburetor mounting nuts	8-12	11-16
Valve cover nut	4-8	6-10
Breaker box mounting screw*	6-8	8-11

* - Use Part No. 513-0347 Sealer.

Note: Use engine oil as a lubricant on all threads EXCEPT for the spark plug, rotor through bolt and breaker box mounting screw.

Section 5. Preparing to Service

TROUBLESHOOTING

Before starting to service the generator set, follow a systematic troubleshooting procedure to locate and isolate the problem. For servicing, the generator set can be considered to consist of four systems:

- Engine - Primary Systems
- Control
- Generator
- Engine - Block Assembly

Several troubleshooting guides are included in this manual to help locate the cause of various malfunctions. It should be noted that some malfunctions might have several possible causes. For this reason, you may have to investigate several likely problem areas in order to isolate the source of the malfunction. Because of the complexity of the equipment, a troubleshooting chart cannot list every malfunction and its cause. In some situations you will have to rely on experience and a knowledge of the product to locate the problem.

REQUIRED TOOLS

The following special tools may be required to service the generator set. A complete listing is available in the Onan Tool Catalog (900-0019).

Engine Tools

Torque wrench, 0-50 ft-lbs.(0-70 N-m)
Feeler gauge
Spark gap gauge
Gear puller
Snap ring pliers
Cylinder ridge reamer
Combination main and cam bearing remover
Combination main and cam bearing driver
Oil seal guide and driver
Piston ring compressor
Piston ring spreader
Cylinder wall flex-hone
Valve seat cutter
Valve spring compressor
Valve lock replacer
Valve seat driver
Valve guide driver
Piston ring groove cleaner
Outside micrometer set, 0-3 inches (0-76 mm)
Telescoping gauge set, 1/2-3 inches (13-76 mm)
Hole gauge, .300-.400 inches (7.5-10 mm)
Plasti-Gage bearing clearance indicator (green)
Lead or dead-blow hammer

Electrical Test Tools and Meters

VOM multi-tester
Armature growler
Load test panel and leads

SAFETY CONSIDERATIONS

Think through and understand the hazards involved in working on generator sets. Read through the safety precautions listed on the inside cover and familiarize yourself with the various hazards shown in Table 5-1. Approach the job with a safety-conscious attitude. This is the most effective way to avoid injury to yourself and to others. Adopt the following safeguards.

Safeguards Against Hazards

- Use personal protection. Wear safety glasses and safety shoes. Don't wear jewelry or loose clothing that might get caught in moving parts or conduct electricity.
- Work to reduce the hazard. Keep fan guards in place and the equipment in good working order. Store flammable liquids in approved containers, away from open flame. Keep the work shop clean, well lit and well ventilated. Keep a fire extinguisher handy.

TABLE 5-1
HAZARDS AND THEIR SOURCE

- Fire and Explosions
  - —Leaking or spilled fuel
  - —Hydrogen gas from battery
  - —Oily rags improperly stored
  - —Flammable liquids improperly stored
- Burns
  - —Hot exhaust pipes
  - —Hot engine and generator surfaces
  - —Electrical short in DC wiring system
- Poisonous Gases
  - —Carbon monoxide from faulty exhaust pipes, joints, or hangers
  - —Operating generator set where exhaust gases can accumulate
- Electrical Shock (AC)
  - —Improper generator set load connections
  - —Faulty RV wiring
  - —Faulty electrical appliance
  - —Faulty generator set wiring
  - —Working in damp conditions
  - —Jewelry touching electrical components
- Rotating Machinery
  - —Jewelry or loose clothing catching in moving parts
- Slippery Surfaces
  - —Leaking or spilled oil
- Heavy Objects
  - —Removing generator set from RV

- Develop safe work habits. Unsafe work habits have been identified as the cause of most accidents involving the use of tools and machines. Be familiar with the equipment and know how to use it safely. Use the correct tool for the job and check its condition before use. Observe the warnings and cautions in this manual. Be extremely cautious when working on electrical equipment. If possible, do not work alone. Don't take risks. Always work safely.

- Be prepared to respond to an emergency. The Red Cross, police and fire departments and other agencies offer courses in first aid, mouth-to-mouth resuscitation and fire control. Take advantage of these opportunities so that you will be ready to respond if necessary.

REMOVAL OF THE SET

Stationary and RV sets will have to be removed from the installation to perform some service operations. Removal will involve disconnection of the high voltage wiring and conduit, remote control wiring, battery cables, fuel line, exhaust pipe and flexible air duct connector (Vacuflo models).

When disconnecting the battery, first disconnect the negative (-) cable at the set to keep sparks as far from the battery as possible. Close the manual fuel shutoff valve in the fuel supply line before disconnecting the set.

If the set utilizes gas fuel, cap or plug the end of the fuel supply line to prevent leakage in case the shutoff valve is inadvertently left open while the set is away for service. Plug or cap the end of the gasoline supply line or drain the tank to the level where spillage cannot occur if the valve is inadvertently opened while the set is away for service.

⚠WARNING ***Gas and gasoline fuel are highly flammable and explosive. If ignited, they can cause severe burns, death and explosion or fire. Make sure that fuel cannot leak while the set is away for service by plugging or capping the fuel supply line in addition to shutting off the valve, or by draining the gasoline supply tank.***

Unbolt the set from the foundation or floor of the RV coach compartment. Remove the set carefully to avoid personal injury or damage to the set. Have someone help lift the set, or use a dolly or fork lift.

Section 6. Engine - Primary Systems

INTRODUCTION

The engine primary systems are as follows:

- Exhaust
- Cooling
- Ignition
- Crankcase Ventilation
- Governor
- Fuel
- Recoil Starter (Manual Start Models)

The engine primary systems can often be serviced without removal or major disassembly of the set. Use the following troubleshooting guide to help locate problems related to the engine primary systems.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Misfires	1. Faulty ignition due to: a. worn or fouled spark plugs, b. worn ignition points, c. incorrect ignition timing, d. faulty magneto (standard) ignition coil (RV). e. faulty plug wires.	 1a. Replace spark plugs. 1b. Replace points. 1c. Adjust timing by servicing the magneto (standard) or breaker points (RV). 1d. Test magneto or coil and replace if necessary. 1e. Test spark plug wires and replace if faulty.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, c. dirt in carburetor, or d. vacuum leak	2a. Adjust carburetor main and idle adjustment screws. 2b. Adjust carburetor float level. 2c. Disassemble carburetor and clean all internal passaages. 2d. Locate leak and correct as required.
	3. Contaminated fuel.	3. Drain fuel tank and refill with fresh fuel.
Engine Backfires	1. Faulty ignition due to: a. incorrect ignition timing or b. incorrect spark plug gap.	1a. Adjust timing. 1b. Reset spark plug gap.
	2. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	2a. Adjust carburetor main and idle adjustment screws. 2b. Adjust carburetor float level. 2c. Disassemble carburetor and clean all internal passages.
	3. Mechanical damage to engine.	3. See Engine Block Assembly section.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Lacks Power	1. Faulty ignition due to: a. incorrect ignition timing or b. incorrect spark plug gap.	1a. Adjust timing. 1b. Reset spark plug gap.
	2. Restricted fuel flow due to: a. plugged fuel filter or b. faulty fuel pump.	2a. Clean fuel filter. 2b. Test fuel pump and repair or replace if faulty.
	3. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws. b. incorrect float level, or c. dirt in carburetor.	3a. Adjust carburetor main and and idle adjustment screws. 3b. Adjust carburetor float level. 3c. Disassemble carburetor and clean all internal passages.
	4. Exhaust system blocked or restricted.	4. Locate and remove cause of of blockage.
	5. Incorrect valve tappet clearance.	5. Adjust valve tappets (see Engine Block Assembly section).
	6. Excessive engine wear or damage to engine.	6. See Engine Block Assembly section.
Engine Overheats	1. Restricted air flow due to dirt and debris blocking fins or blower blades.	1. Clean with brush and compressed air.
	2. Incorrect ignition timing.	2. Adjust timing.
	3. Lean fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level, or c. dirt in carburetor.	3a. Adjust carburetor main and idle adjustment screws. 3b. Adjust carburetor float level. 3c. Disassemble carburetor and clean all internal passages.
	4. Engine compartment ventilation openings restricted.	4. Remove restrictions.
Black Exhaust	1. Rich fuel mixture due to: a. choke sticking, b. incorrectly adjusted fuel mixture c. dirt in carburetor.	1a. Clean choke and choke linkage. 1b. Adjust carburetor idle and main adjustment screws. 1c. Disassemble carburetor and clean all internal passages.

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLESHOOTING ENGINE PRIMARY SYSTEMS (Continued)

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Hunts or Surges	1. Sticking or binding governor linkage.	1a. Clean and lubricate governor linkage.
	2. Incorrect governor adjustment.	2. Adjust governor speed and sensitivity.
	3. Faulty governor spring.	3. Replace governor spring.
	4. Incorrect fuel mixture due to: a. incorrectly adjusted fuel mixture screws, b. incorrect float level or c. dirt in carburetor.	4a. Adjust carburetor main and idle adjustment screws. 4b. Adjust carburetor float level. 4c. Disassemble carburetor and clean all internal passages.
	5. Governor mechanism worn excessively.	5. See Engine Block Assembly section.
High Oil Consumption (Note: New engines sometimes have high oil consumption during break-in)	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	2. Crankcase breather valve is dirty or defective.	2. Clean crankcase breather and replace if defective.
	3. Oil leaks.	3. Locate source of leak and repair as required.
	4. Excessive engine wear.	4. See Engine Block Assembly section.
	5. Light loading.	5. Do not run set at no load for long periods of time.
Low Oil Pressure	1. Oil viscosity too light or oil is diluted.	1. Drain oil and refill with correct viscosity oil.
	2. Low oil level.	2. Add oil as required.
	3. Low oil pressure switch defective.	3. Replace oil pressure switch (see Engine Block Assembly section).
	4. Faulty oil bypass valve.	4. Inspect oil bypass valve and clean or replace as required (see Engine Block Assembly section).
	5. Excessive engine wear or defective oil pump.	5. See Engine Block Assembly Section

EXHAUST SYSTEM

Standard Configuration

The muffler is secured to the generator set. The outlet is threaded for connection of 1 inch pipe. Generator sets installed indoors must have the exhaust piped to the out-of-doors.

⚠WARNING ***Exhaust gas is deadly! Make sure the exhaust system is adequate to remove all exhaust gas and that it does not leak. If a leak is detected, shut off the set immediately and repair it.***

The following provisions are essential for an exhaust system:

- Use a flexible connector to isolate engine vibration from the exhaust piping.
- Use 1 inch or larger Schedule 40 black iron pipe.
- Route the pipe at least 12 in. from combustible construction and fuel lines. Use an approved thimble to maintain the clearance through walls.

⚠WARNING ***Exhaust piping is hot and can cause a fire if clearances are not maintained. Check for compliance with local building codes.***

- If the piping terminates vertically, provide a rain cap.
- Provide a condensate drip leg where piping turns to rise vertically.
- Slope horizontal pipe to drain to a drip leg or to the outside.
- Use sweeping bends to minimize exhaust back pressure.
- Do not terminate the exhaust pipe near a window, door or building air intake opening. Check for compliance with local building codes.
- Support exhaust piping with non-combustible hangers. The muffler must not bear any of the weight of the piping.
- Check for exhaust leaks or corroded muffler and piping. Do not operate the generator set until the exhaust system has been repaired and is free of leaks.

Refer to the Operator's Manual for further details concerning the exhaust system.

RV Configuration

The condition of the exhaust system is critical on RV generator sets because of the possibility of exhaust gases entering the vehicle.

The exhaust system consists of the muffler, exhaust pipe, clamps and hangers needed for installation. Figure 6-1 shows a typical exhaust system for a compartment mounted generator set.

The generator set must be shut down and the exhaust system serviced immediately if inspection reveals leaks, loose fasteners, or corroded or damaged components.

Always replace faulty components with original equipment replacement parts. Do not attempt to repair a broken exhaust pipe or manifold by welding. The muffler is of the spark arrester type Approved by the Forest Service. Failure to provide and maintain a spark arrester muffler can be a violation of the law. Contact an Onan distributor for approved replacement exhaust parts.

⚠WARNING ***Exhaust gas is deadly! Modifying the exhaust system can allow poisonous exhaust gases to enter the coach. Use only original equipment replacement parts when servicing the exhaust system. Unauthorized modifications will also void the warranty and cancel the UL Listing or CSA Certification. Liability for injury or damages due to unauthorized modifications become the responsibility of the person making the change.***

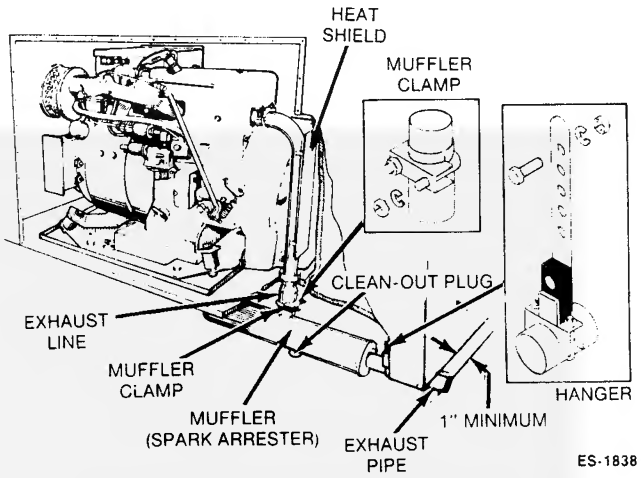

FIGURE 6-1. TYPICAL RV EXHAUST SYSTEM

Do not terminate the exhaust tailpipe under the fuel tank fill spout. The hot tailpipe could ignite spilled fuel. Do not terminate the exhaust tailpipe under any door or window that can be opened.

No part of the exhaust system shall intrude into the departure angle or approach angle unless it is adequately protected by a skid bar or other protective device. See Figure 6-2. Use a sufficient number of hangers to prevent damage or dislocation of the system.

⚠WARNING ***Exhaust gases are deadly! Do not terminate the tailpipe under the vehicle. Direct exhaust gases away from any vent, window, door, or any opening which can be opened and is not permanently sealed from the vehicle living space. Do not mount any portion of the exhaust system into the departure angle or approach angle unless it is adequately protected. Use a sufficient number of hangers to prevent damage or dislocation of the exhaust system.***

⚠CAUTION ***Excessive exhaust back pressure can cause engine damage. If a tailpipe deflector is used, make sure it is large enough not to cause back pressure.***

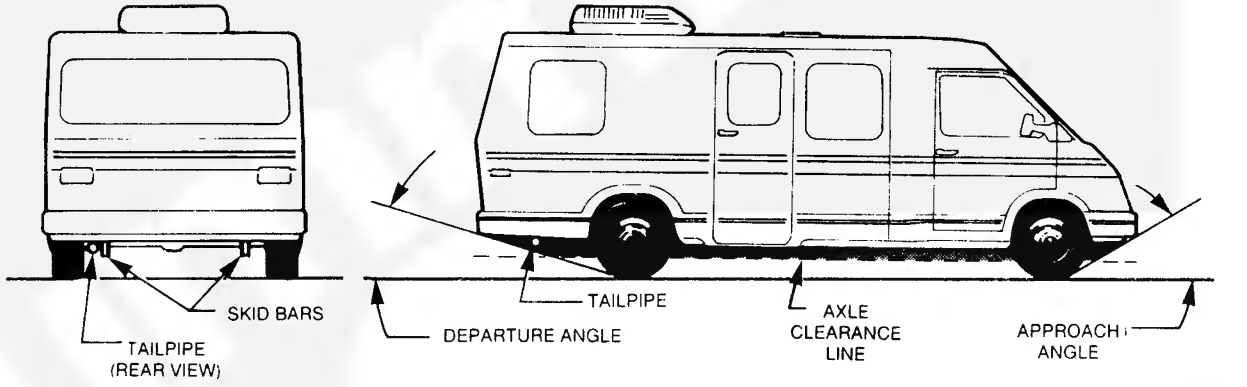

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FIGURE 6-2. TAILPIPE INSTALLATION

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Never sleep in vehicle with the generator set running unless the vehicle interior is equipped with an operating carbon monoxide detector. Protection against carbon monoxide inhalation also includes proper exhaust system installation and visual and audible inspection of the complete exhaust system at the start of each generator set operation.

1-RV

COOLING SYSTEM

Generator sets produce considerable heat that must be removed from the set in order to maintain a normal operating temperature. These generator sets have air cooled engines. The cooling system consists of a centrifugal blower driven by the crankshaft, cylinder and head cooling fins and sheetmetal shrouds to direct the air flow across the cooling fins. Pressure cooled models push the air through the cooling fins and Vacu-flo and RV models pull the air through in the reverse direction.

Ventilation of the room or compartment enclosing a generator set is necessary to remove the hot air discharged from the set.

For pressure cooled sets, an inlet opening of at least 1 square foot (.1 square metre) and an outlet opening of at least 2 square feet (.2 square metres) are required for ventilation. The inlet opening should be opposite the blower inlet and the outlet opening above the set and towards the opposite end of the room from the inlet opening.

For Vacu-flo cooled sets, an inlet opening of at least 41 square inches (.025 square metres) and a flexible air duct between the outlet of the blower and the out-of-doors are required.

For RV sets, an inlet opening of at least 50 square inches (.03 square metres) is required. The air should be discharged directly to the outside through an opening in the compartment floor that matches the outlet of the blower.

See the Operator's Manual for details about windbreaks, louvers, acoustic baffles, etc. that may be needed for the ventilation openings.

If there is an accumulation of dust and debris on the set, use a brush and compressed air (30 psi (200 kPa) maximum pressure) to clean the cooling fins and blades of the blower. The blower housing and shrouds are easily removable.

⚠CAUTION ***The engine will overheat and be damaged if operated without the blower housing and shrouds in place. Replace as soon as cleaning has been done.***

⚠WARNING ***Accidental starting of the generator set with the blower housing off can cause severe injury or death. Prevent accidental starting by turning the control panel switch OFF and disconnecting the battery.***

Always disconnect a battery by removing the cable from the negative (-) post first. This will prevent arcing if a tool is accidentally touched between the positive (+) post of the battery and the frame or other grounded metal parts.

⚠WARNING ***Exhaust gases are deadly! Cooling air discharged from the blower may include exhaust gases. Never heat an RV coach or other enclosed space with cooling air discharged from the blower.***

IGNITION SYSTEM

Maintenance and adjustments of the ignition system must be done on a regular basis as specified in the Owner's Manual if the generator set is to perform as expected. Several problems can be traced to a faulty ignition system. For example, a fouled spark plug can cause misfiring. Retarded ignition timing can cause hard starting and loss of power. Advanced ignition timing can cause loss of power and overheating.

Standard models use a magneto ignition system and RV models a battery ignition system. Refer to Section 7. Control, for wiring schematics of the ignition systems.

Magneto Ignition System

The magneto ignition system consists of flywheel mounted magnets, magneto pole shoe, primary and secondary magneto windings, breaker points, capacitor, spark plug, high tension spark plug lead, and shutoff switch. The magneto assembly and breaker points are mounted on the gear case and are accessible by removing the flywheel. Figure 6-3 illustrates the magneto ignition system.

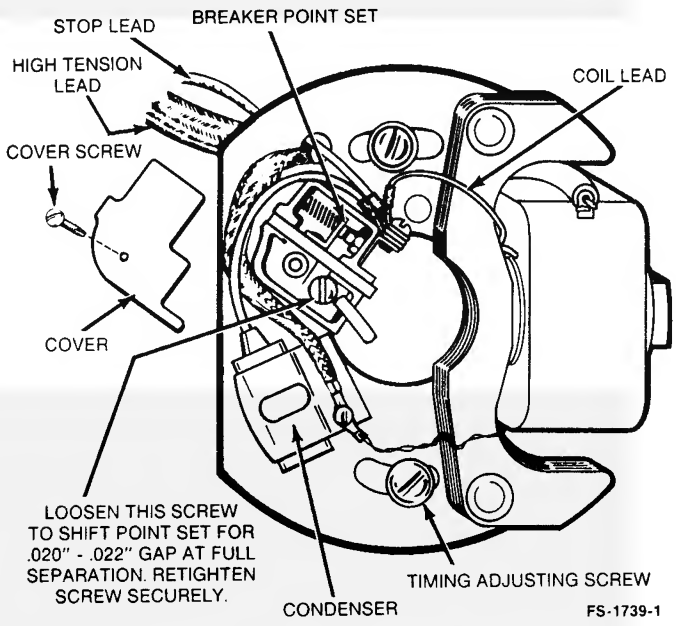


FIGURE 6-3. MAGNETO IGNITION SYSTEM

Principle of Operation: The flywheel magnets pass across the top of the magneto pole shoe on each rotation of the crankshaft. As a result, induced current flows through the primary windings of the magneto, building up a magnetic field. The breaker points abruptly cut off the the induced current as the crankshaft reaches the position before piston top center (TC) determined by ignition timing. As a result, the magnetic field of the magneto rapidly collapses, inducing more than 20,000 volts in the secondary windings. The voltage is enough to jump the spark plug gap to ignite the fuel (which is present every other rotation). The capacitor is connected across the breaker points to reduce sparking and consequent pitting when they open to break the current in the primary winding of the magneto.

Breaker Point Maintenance and Ignition Timing Procedure:

1. On remote controlled sets, disconnect the battery to prevent accidental starting while working.

   ⚠WARNING ***Accidental starting of the generator set with the blower housing off can cause severe injury or death. Prevent accidental starting by turning the control panel switch OFF and disconnecting the battery.***

   Always disconnect a battery by removing the cable from the negative (-) post first. This will prevent arcing if a tool is accidentally touched between the positive (+) post of the battery and the frame or other grounded metal parts.

2. Remove the blower housing.
3. Remove the flywheel. After loosening the flywheel bolt, give the hub a sharp rap with a lead hammer to free the taper fit on the crankshaft.
4. Remove the spark plug to make turning the engine easier.
5. Remove the breaker point cover and examine the points. Replace burned or pitted points and the capacitor. Filing points is not recommended.
6. Rotate the crankshaft until the highest point on the cam is under the breaker point rubbing block. Measure the point gap and adjust to specifications.
7. Connect an ohmmeter across the points to indicate when they open. Place the flywheel back on the shaft, with the key in place, and rotate until the mark on the flywheel lines up with the specified mark on the gear case (see Specifications). The breaker points should open just as the marks line up. Loosen the magneto back plate mounting screws and rotate the plate clockwise if the points separate too soon and counterclockwise if they separate too late.
8. Reassemble the parts in the reverse order.

Tests of a Faulty Ignition System: If the ignition system is suspected of being faulty, disconnect the high tension lead from the spark plug, hold the terminal connector (with a pair of insulating pliers) about 3/16 inch from the cylinder head and crank the engine. There should be a good spark. If not, service as follows:

1. Disconnect the high tension lead from the spark plug and measure the resistance between the terminal and ground with an ohmmeter. The resistance should be approximately 10,000 ohms. If it is greater, either the high tension lead or the secondary winding of the magneto is open or has a high resistance. If the resistance is low, the winding is probably shorted. Replace the high tension lead or magneto coil as necessary.

2. Remove the flywheel and service the ignition points and capacitor as described above.
3. Check for a short between the primary and secondary windings of the magneto with an ohmmeter. A low resistance between the leads of the separate windings indicates a defective coil that should be replaced.
4. The flywheel magnets should not lose strength or be affected by dropping the flywheel. If magnetism is lost, return the flywheel to the factory for re-magnetism.

Battery Ignition System

The battery ignition system consists of an ignition coil, breaker points, capacitor, spark plug, high tension spark plug lead and shutoff switch. Ignition energy is supplied by a 12 volt battery. The breaker points assembly is mounted on the service side of the engine. The points are opened by a plunger driven by the camshaft. Figure 6-4 illustrates the components of the system.

Principle of Operation: Current flows from the battery through the primary winding of the ignition coil, building up a magnetic field in the coil. The plunger driven by the camshaft abruptly opens the breaker points at the correct time before the piston reaches top center (TC). (Ignition timing is not adjustable except as point gap affects timing.) As a result, the magnetic field in the coil rapidly collapses, inducing more than 20,000 volts in the secondary winding of the ignition coil, which is enough to jump the gap in the spark plug and ignite the fuel. The capacitor is connected across the breaker points to reduce sparking and consequent pitting when the points open.

Breaker Point Maintenance and Ignition Timing Procedure:

1. Remove the cover from the breaker point box and examine the points. Burned or pitted points and the capacitor should be replaced. Filing points is not recommended.
2. Remove the spark plug to make turning the engine easier.
3. Turn the engine until the mark "22" (22 degrees before top center) on the blower is visible through the peep hole in the side of the blower housing (Figure 6-5). Watch for the breaker point plunger to move. If it does not move, turn the crankshaft one full revolution clockwise. (The breaker points open every other revolution.) Turn the crankshaft a few more degrees to ensure full opening of the points. Adjust the point gap according to specifications.
4. The ignition timing should be correct if the point gap is within specifications. Timing can be checked with a timing light directed at the timing mark on the blower. There is also a notch in the edge of the blower wheel visible with a timing light through a peep hole in the scroll of the housing.

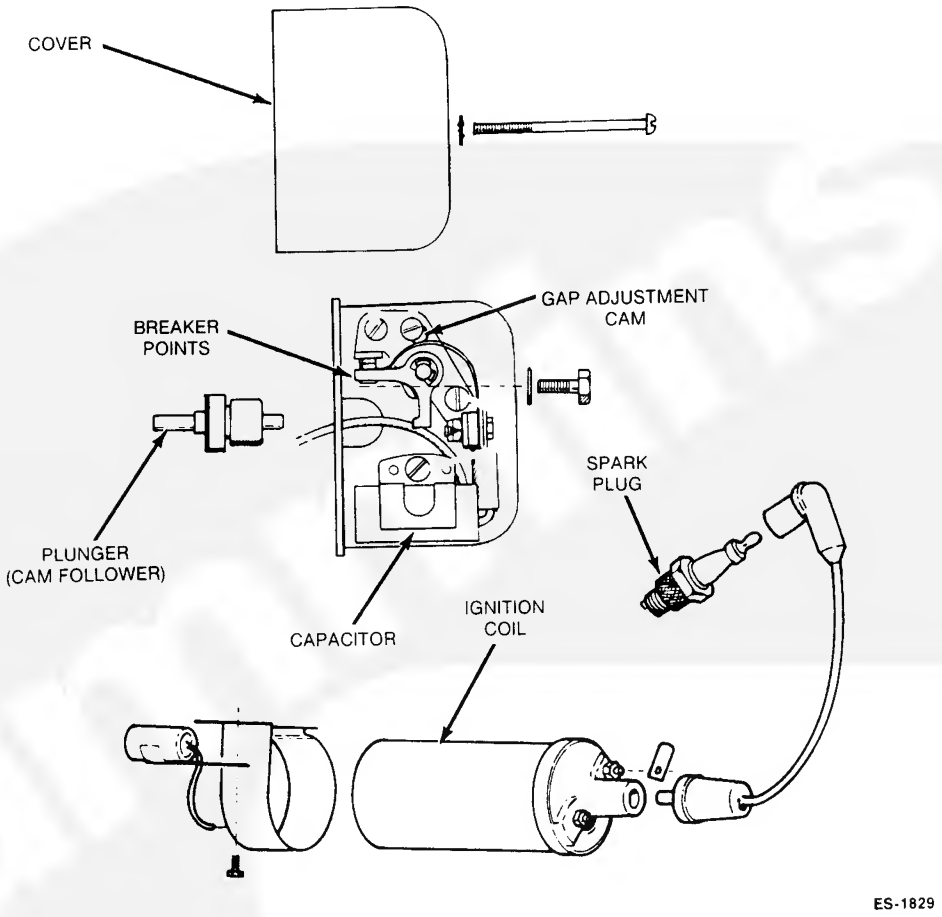


FIGURE 6-4. BATTERY IGNITION SYSTEM

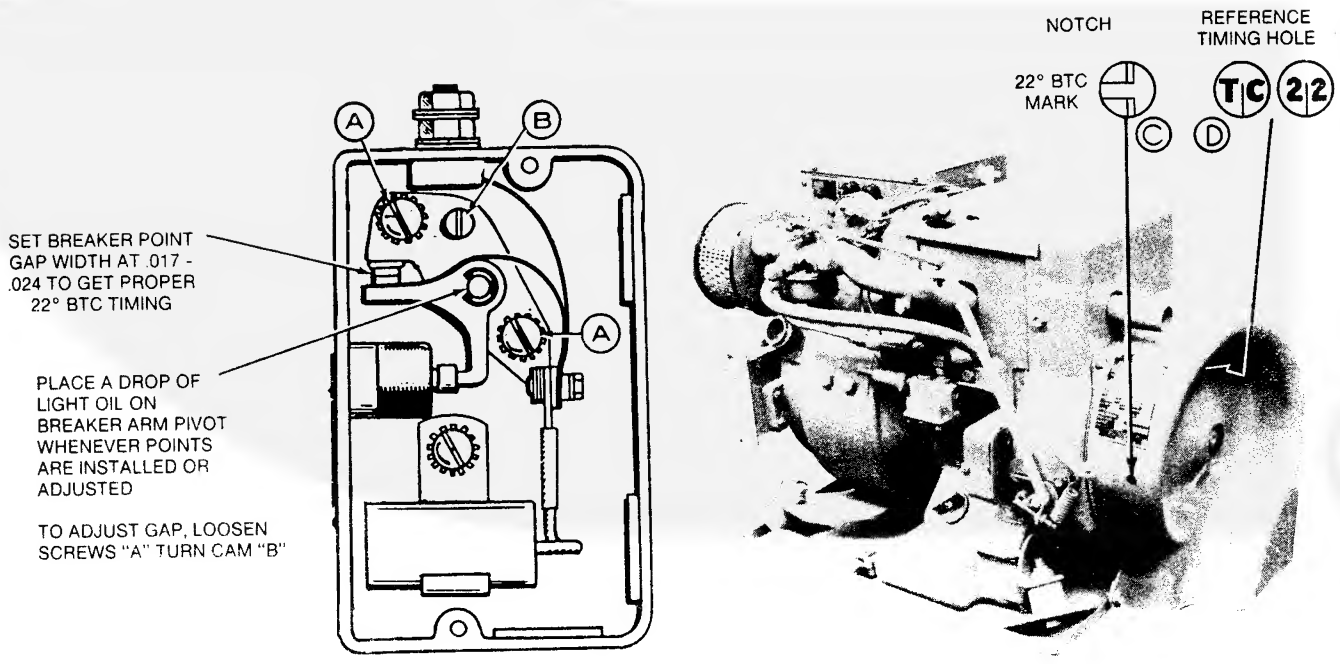


FIGURE 6-5. IGNITION AND TIMING ADJUSTMENTS

Tests of a Faulty Ignition System: If the ignition system is suspected of being faulty, disconnect the high tension lead from the spark plug, hold the terminal connector(with an insulating pliers) about 3/16 inch from the cylinder head and crank the engine. There should be a good spark. If not, service as follows:

1. Disconnect the high tension lead from the spark plug and check the resistance between the terminal and ground with an ohmmeter. The resistance should be approximately 10,000 ohms. If it is greater, the high tension lead or the secondary winding is open or has a high resistance. If the resistance is low, the secondary winding is shorted. Replace a faulty coil or high tension lead.
2. Check the resistance between the leads and terminals of the separate primary and secondary windings of the ignition coil. A low resistance indicates a faulty coil that should be replaced.
3. Service the breaker points and replace the capacitor as described in the maintenance procedure above.

Spark Plug

A fouled or burned spark plug can cause hard starting, misfiring and loss of power under load.

Remove the spark plug for inspection, cleaning and regapping (Figure 6-6). Replace a fouled or discolored spark plug.

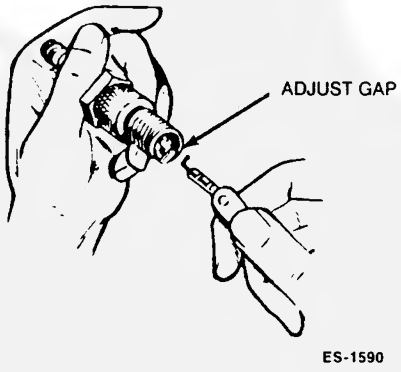


FIGURE 6-6. SPARK PLUG GAP

CRANKCASE VENTILATION SYSTEM

The crankcase breather prevents pressure from building up in the crankcase. It also prevents oil contamination by removing moisture, gasoline vapors and other harmful blow-by gases from the crankcase. These vapors are routed to the carburetor where they are mixed with incoming air and burned in the combustion chamber. A sticky breather valve can cause oil leaks, high oil consumption, rough idle, reduced engine power, rapid formation of sludge and varnish within the engine, or oil in the breaker point box.

At 100-hour intervals, or if the crankcase becomes pressurized as evidenced by oil leaks at the seals, remove the breather tube (Figure 6-7) from the valve cover and examine the breather valve. If there is an accumulation of sludge and dirt, replace the valve.

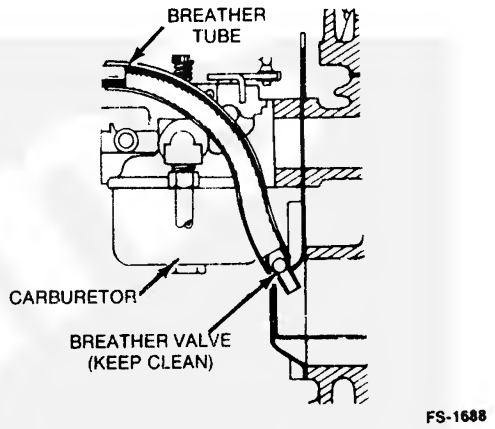


FIGURE 6-7. CRANKCASE BREATHER

GOVERNOR

General

- The governor controls engine speed. An increase in engine speed causes a corresponding increase in generator voltage and frequency, or battery charging rate on battery charger models. By maintaining engine speed under changing load conditions, the governor holds generator output frequency and voltage steady.
- The carburetor fuel mixture screws must be correctly adjusted before governor adjustments are made. If the carburetor needs adjusting, refer to *Fuel System* in this section before making any adjustments to the governor.
- An accurate voltmeter should be connected across the generator output connections in order to correctly adjust the governor. A slight decrease in the speed adjustment can lead to an objectionable drop in voltage.
- Before making governor adjustments, run the set about 10 minutes under one half to three quarters of the rated load to reach normal operating temperature. If the governor is completely out of adjustment, make a preliminary adjustment at no load to obtain a safe speed.
- Check the throttle assembly and governor linkage for smooth movement without binding. If the governor performs erratically after all governor and carburetor adjustments have been made, replace the governor spring. If that does not improve operation, the problem is probably within the governor mechanism. Refer to the Governor Cup in Section 9 for service procedures.

⚠CAUTION ***The muffler and exhaust pipes get hot and can cause burns. Use caution when making adjustments while the engine is running.***

Governor Adjustment: Standard AC Models

With the set shut down, the length of link A, as shown in Figure 6-8, must be such that the tang on the throttle lever just comes short of touching the boss on the carburetor. The clearance should not be more than 1/32 inch. Make sure the link is under governor spring tension while measuring the clearance. Turn the ball joint on the threaded end of the link to make the adjustment.

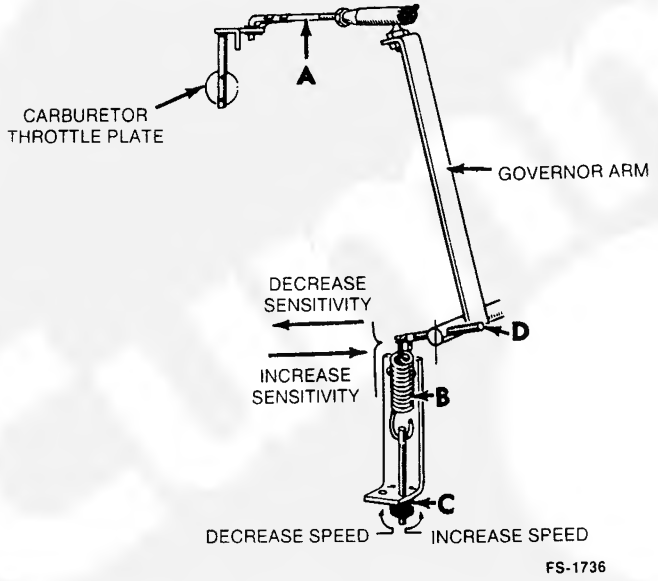


FIGURE 6-8. GOVERNOR ADJUSTMENT: STANDARD MODELS

With the set running at no load, adjust speed nut C for an output of 126 volts for 120 volt models and 252 volts for 240 volt models. Connect a full rated load and check output voltage again. The voltage should not fall below 108 volts for 120 volt models or below 216 volts for 240 volt models.

If the voltage drop is too great when the full load is connected, turn sensitivity screw D clockwise. If the output voltage is within limits but unsteady (generator set hunts), turn the sensitivity screw D counterclockwise. Any change in sensitivity screw D requires a readjustment of speed adjustment nut C.

Some sets have an automatic idle device that drops engine speed to approximately 1800 RPM (Figure 6-9) when the load drops to less than 100 watts, and restores normal speed when the load is reconnected. Refer to Section 7, Control, for description of the idle device control and associated wiring.

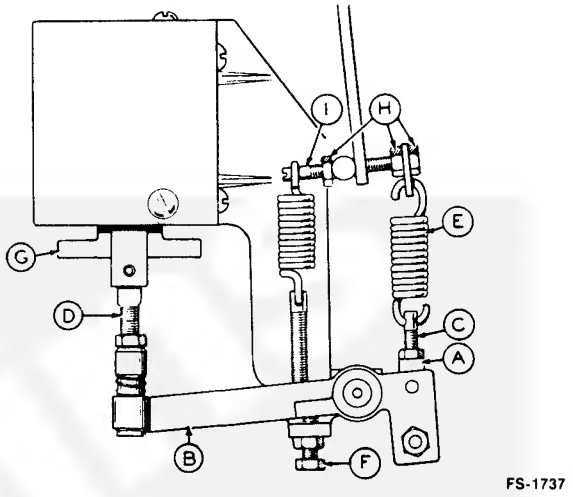


FIGURE 6-9. AUTOMATIC IDLE DEVICE

To adjust the idle device, turn off the control switch and adjust screw C if necessary so that there is no tension on spring E. Make sure the carburetor has been adjusted properly. Disconnect flexible joint A from lever B. The socket slips off the ball. Adjust the governor for normal operation by the procedure above, with lock nuts H loose. Tighten lock nuts H with the link for spring E as far out on the sensitivity screw as possible. Reconnect joint A to link B. Turn stop adjusting screw F down to allow maximum lever movement.

Turn on the control switch. With no electrical load, the solenoid should pull up with enough force to overcome the governor spring and reduce engine speed to approximately 1800 RPM. Voltage will be approximately 55 volts. If the speed is too high, either link C or D can be shortened; or lengthened if the speed is too low. The armature of the solenoid drops when load is connected. With a full electrical load connected, adjust screw F so that spring E is firm but not stretched. Tighten all the lock nuts.

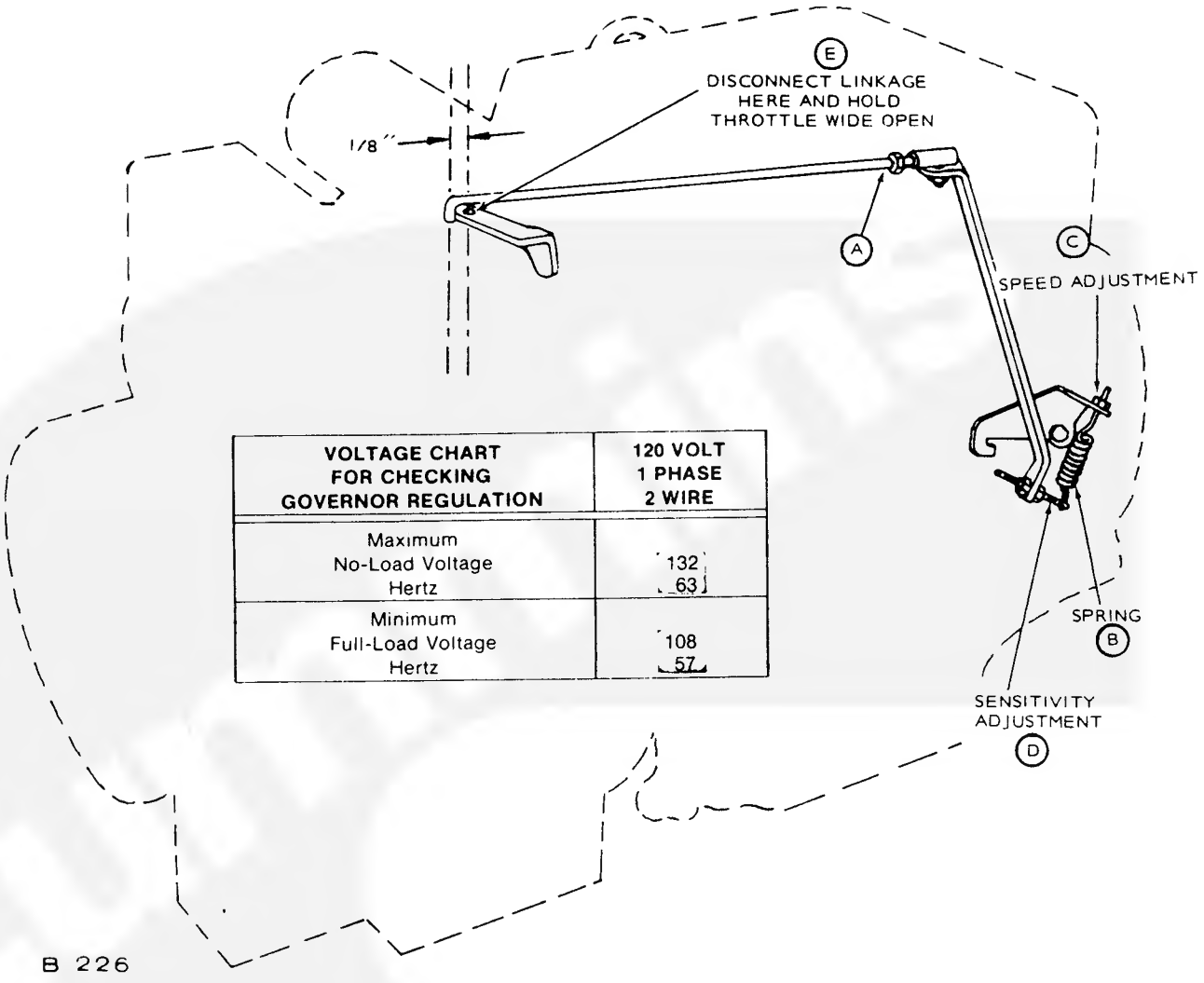
⚠CAUTION ***Never operate the set with solenoid plunger G removed unless the idle device control switch is off.***

Governor Adjustment: Battery Charger Models

Turn speed nut C, as shown in Figure 6-8, to obtain the desired charge rate. Normal speed as specified on the nameplate is approximately 2400 RPM. If the charge rate tends to taper off too soon, turn sensitivity screw D clockwise. If the charge rate is unsteady, turn screw D counterclockwise.

Governor Adjustment: RV Models

With the engine shut down, disconnect link A, as shown in Figure 6-10, from the throttle shaft. While holding the throttle wide open against the stop, adjust the length of link A so that the center line of the elbow is 1/8 inch beyond the center of the hole. Make sure the link is under governor spring tension. Turn the ball joint on the threaded end of the link to make the adjustment. Reengage the link.



VOLTAGE CHART FOR CHECKING GOVERNOR REGULATION	120 VOLT 1 PHASE 2 WIRE
Maximum No-Load Voltage Hertz	132 63
Minimum Full-Load Voltage Hertz	108 57

FIGURE 6-10. GOVERNOR ADJUSTMENT: RV MODELS

With the set running at no load, adjust speed nut C for an output of 126 volts for 120 volt models and 252 volts for 240 volt models. Connect a full rated load and check output voltage again. The voltage should not fall below 108 volts for 120 volt models or below 216 volts for 240 volt models

If the voltage drop is too great when the full load is connected, turn sensitivity screw D counterclockwise. If the output voltage is within limits but unsteady (generator set hunts), turn the sensitivity screw D clockwise. Any change in sensitivity screw D requires a readjustment of speed adjustment nut C.

Lubrication of Governor Linkage

Clean and lubricate the governor linkage joints with powdered graphite as shown in Figure 6-11.

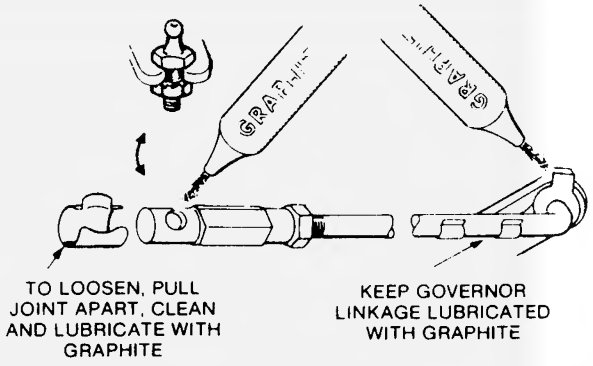


FIGURE 6-11. GOVERNOR LINKAGE

FUEL SYSTEM

The fuel system must be in good condition and properly adjusted for efficient generator set operation. The main components of the fuel system are the carburetor, fuel pump, fuel filter and choke. On gas fuel sets, they are the carburetor and gas demand regulator.

Carburetor Adjustments

The most common cause of poor carburetion is maladjustment of the idle and/or main mixture adjustment screws. Significant variation from the correct settings may result in serious damage to the engine. An overly rich mixture not only wastes fuel, but can increase engine wear by washing the lubricant from the cylinder walls and diluting the crankcase oil. An overly lean mixture results in a loss of power, flat spots in acceleration, and a greater tendency to burn valves and spark plugs.

Make sure that the ignition system works properly and that timing is correct. Allow the engine to warm-up before making fuel mixture adjustments. If the carburetor (Figure 6-12) is completely out of adjustment and the engine will not run, lightly turn in both adjustment screws by hand until they bottom. Then back out the idle screw one turn (1-1/4 turns for RV Models) and the main fuel screw 2-1/2 turns (1-1/4 turns for RV Models) so that the engine will start and run. (On some RV sets the main fuel mixture is not adjustable).

⚠CAUTION ***Forcing a mixture adjustment screw to bottom will damage the needle and seat. Turn the screw lightly by hand until it bottoms on the seat.***

Mixture Adjustments - Standard Models:

1. Connect a full load to the set.
2. Turn in the main fuel adjustment screw until the engine begins to loose speed (voltage drops). Then turn out the screw just enough so that the engine can carry the full load at the minimum allowable voltage. Check operation under various loads. If there is a tendency to hunt, turn out the screw until operation becomes stable, but not more than 1/2 turn past the point of smooth full load operation.
3. Disconnect the load from the set. On battery charger models, make adjustments at the lowest possible charge rate.
4. Turn in the idle fuel adjustment screw until the engine speed drops slightly. Then turn out the screw until the speed returns to normal.
5. Continue running the set without load. Lightly turn in the throttle stop screw until it just touches the tang on the throttle lever, and then back it off one full turn.

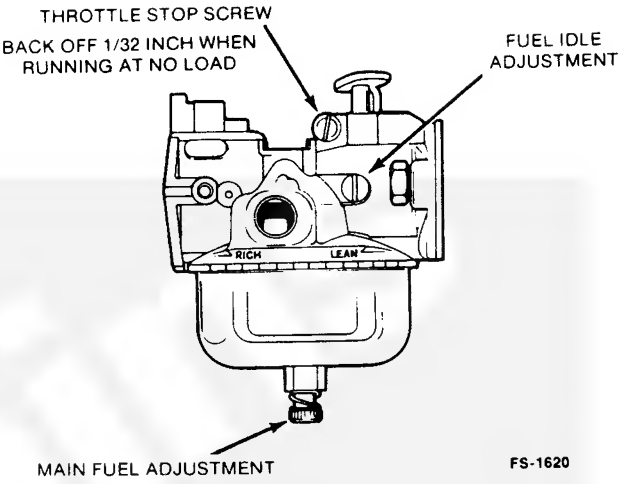


FIGURE 6-12. ADJUSTING CARBURETOR

Mixture Adjustments - RV Models:

1. Remove the load from the set.
2. Move the governor arm to bring the throttle up against the stop screw and adjust the stop screw to obtain 75 to 80 volts output.
3. Continue to hold the throttle up against the stop screw while turning the idle adjustment screw in until the voltage drops. Then turn the screw out until the highest voltage is obtained.
4. Release the governor arm. The engine should accelerate to governed speed and stabilize.
5. Connect the full rated load.
6. Turn the main fuel adjustment screw to obtain the highest possible voltage. (On some sets the main fuel mixture is not adjustable).
7. Remove the load and move the governor arm to obtain the minimum speed. Release the arm. If surging occurs, turn the main fuel adjustment screw out slightly, and repeat the test. If surging continues, adjust the governor sensitivity.

Carburetor Overhaul

Carburetor problems not corrected by adjustments are usually a result of gummed-up fuel passages or worn internal parts. The most effective solution is to overhaul the carburetor. This consists of complete disassembly, thorough cleaning and replacement of worn parts. Carburetor repair kits are available that supply new gaskets and replacements for those parts most subject to wear. Figure 6-13 is an exploded view of the carburetor, showing all the parts.

Disassembly Procedure:

1. Shut off the fuel supply, or drain the set mounted fuel tank and store the fuel in an approved safety container.

   ⚠WARNING ***Gasoline is highly flammable. Ignition can cause severe burns or death or destruction of equipment and property by fire or explosion. Store gasoline in an approved container and keep away from flames, cigarettes, sparks, equipment with pilot flames, electrical arcs or other ignition sources.***

2. Disconnect the fuel line, governor linkage, electric choke wire and linkage and air cleaner and adapter. Loosen the mounting nuts or bolts and remove the carburetor from the manifold.
3. Remove the throttle and choke plate retaining screws. Remove the plates. Pull out the throttle and choke shafts, being careful not to damage the teflon coating applied to some throttle shafts.
4. Remove the main fuel and idle adjustment screws and springs.
5. Unscrew the main fuel adjustment retaining nut and remove the fuel bowl from the carburetor.
6. Carefully note the position of the float assembly parts and then slide out the retaining pin and remove the float assembly and the needle valve.
7. Unscrew and remove the needle valve seat.

Cleaning and Repair:

1. Soak all metal components that are to be reused in a carburetor cleaning solution. Do not soak the float, needle valve, valve seat or other non-metal parts.
2. Clean all carbon from the carburetor bore, especially where the throttle and choke plates seat. Be careful not to plug the idle or main fuel parts.
3. Blow out all pasages with compressed air. Do not use wire or other objects for cleaning critical passages.
4. Check the condition of any needle valve not included in the repair kit and replace if damaged (Figure 6-14). Replace the float if it is filled with fuel or damaged.

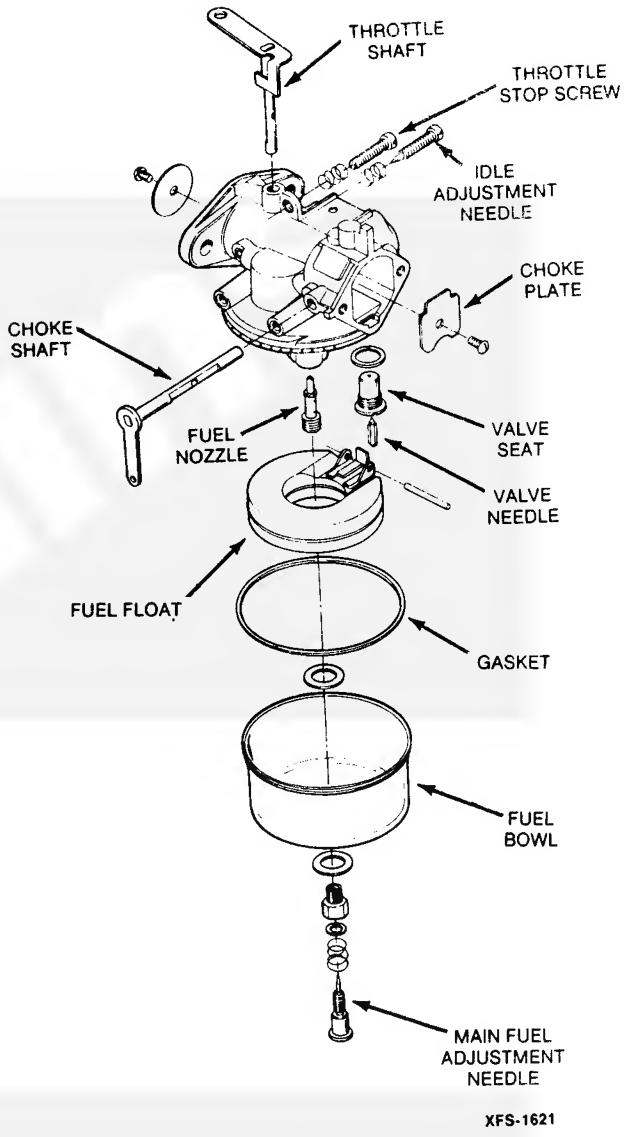


FIGURE 6-13. CARBURETOR COMPONENTS

FIGURE 6-14. MIXTURE NEEDLE INSPECTION

5. Check the choke and throttle shafts for excessive play in their bores, and replace if necessary.
6. Replace old components with new parts included in the repair kit.

Reassembly and Installation:

1. Install the needle valve and seat, fuel bowl gasket, and float assembly. Make sure that all clips and springs are properly placed and that the float moves freely without binding. Check the float level and adjust as necessary by bending the seat tab (Figure 6-15).

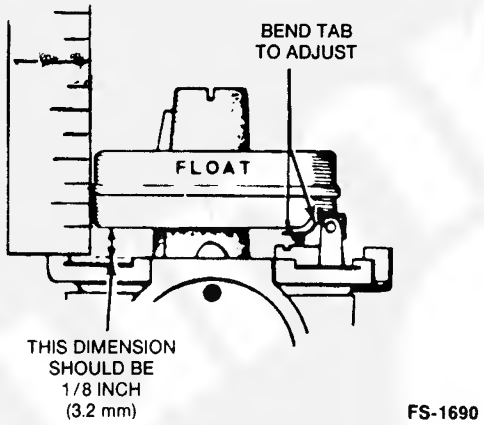


FIGURE 6-15. CARBURETOR FLOAT ADJUSTMENT

2. Rejoin the bowl to the carburetor body.
3. Slide in the throttle shaft and install the throttle plate. Before tightening the screws, the plate must be centered in the bore. To do so, back off the throttle stop screw as necessary and completely close the throttle lever. Seat the plate by tapping with a small screwdriver, then tighten the screws. Install the choke shaft and plate in the same manner.
4. Install the main fuel and idle adjustment screws and springs. Turn in the screws until lightly seated and then turn out as indicated under Mixture Adjustments above.

⚠CAUTION ***Forcing a mixture adjustment screw to bottom will damage the needle and seat. Turn the screw lightly by hand until it bottoms on the seat.***

5. Reinstall the carburetor on the engine and connect the fuel line, links, and wires.
6. Adjust the carburetor and governor to restore the set to operation.

Fuel Pump

A diaphragm type fuel pump is used. If fuel does not reach the carburetor, check the fuel pump. Be sure there is fuel in the tank. If the fuel line is open and no fuel comes through, the pump is defective. Failure of the pump is usually due to a leaking diaphragm valve or valve gasket, a weak or broken spring, or wear in the drive linkage. Oil diluted with gasoline may indicate a faulty diaphragm.

Removal:

1. Shut off the fuel supply and remove the fuel inlet and outlet lines from the pump.

⚠WARNING ***Gasoline is highly flammable. Ignition can cause severe burns or death or destruction of equipment and property by fire or explosion. Keep away from flames, cigarettes, sparks, equipment with pilot flames, electrical arcs and other sources of ignition while servicing the pump.***

1. Remove the two capscrews holding the pump to the engine.
2. Remove the pump and gasket from the engine and discard the gasket.

Installation:

1. Remove all gasket material from mounting faces. Apply oil-resistant sealer to both sides of the gasket and to the threads of the attaching capscrews.
2. Place the gasket on the mounting face of the pump. Slide the mounting capscrews through the pump and gasket to prevent the gasket from slipping out of place.
3. Lightly place the pump in position on the engine, making sure the rocker arm is riding on the camshaft lobe. Start both capscrews and check for proper gasket placement. Alternately torque capscrews to specifications.
4. Connect the fuel inlet and outlet lines.
5. Operate the engine and check for leaks.

Repair: Repair kits are available that provide replacement parts for the pump which are most subject to wear. Use all parts included in the repair kit. Proceed as follows:

1. After the pump is removed from the engine, scribe a line on the flanges of the upper and lower pump bodies to assure correct reassembly.
2. Remove the securing screws and separate the upper and lower pump bodies.
3. Detach the valve cage retainer from the pump upper body. Noting their position, remove the valve and cage assemblies and their gaskets from the retainer (Figure 6-16).

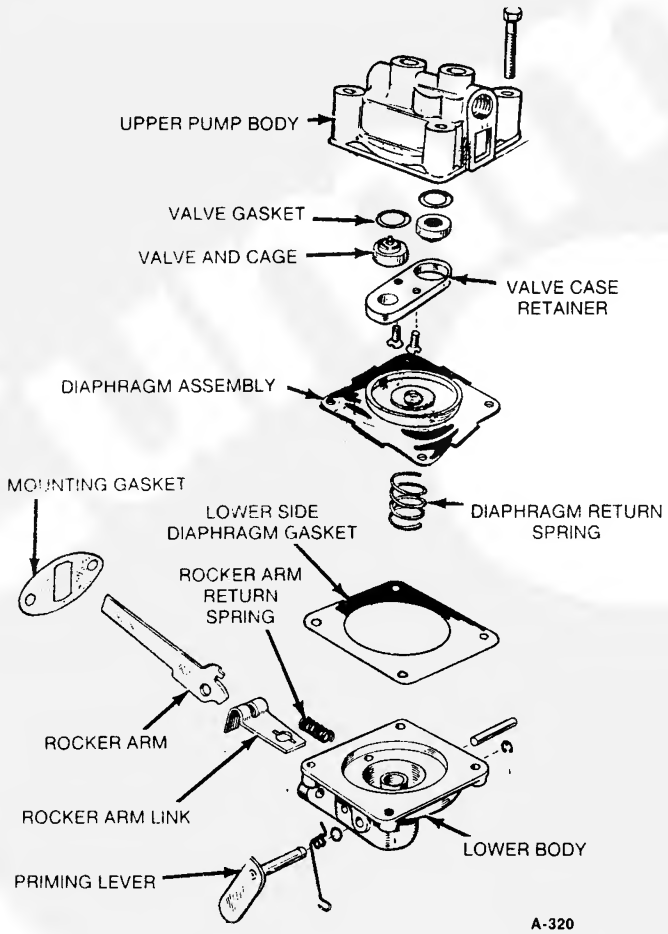


FIGURE 6-16. EXPLODED VIEW OF PUMP

4. Detach the pump diaphragm by pressing its metal base into the pump body and turning it 1/4 turn (Figure 6-16).
5. The rocker arm return spring can normally be removed without removal of the rocker arm from the pump body. Use a small screwdriver or tweezers to compress the spring and tip it off the rocker arm catch. When installing the new spring, make sure it is properly placed before remounting the pump.
6. Use solvent to clean all parts that are to be reused, and allow them to dry.
7. Install new valves and cage assemblies and their gaskets in the retainer. Be sure the assemblies are in proper position and fully seated. Reinstall the retainer and assemblies in the pump upper body.
8. To install the new pump diaphragm, turn the pump lower body upside-down and place the diaphragm and spring in the body. Press the base of the diaphragm up into the body of the pump and turn 1/4 turn.
9. Install a new rocker arm return spring. Check for proper spring placement.
10. Place the upper and lower bodies of the pump together, with the scribe marks aligned. Start the four securing screws, making sure they do not chew into the diaphragm fabric. Leave the screws 2 or 3 turns loose.
11. Operate the rocker arm several times to flex the new diaphragm. While holding the rocker arm fully flexed, tighten the body screws.

⚠CAUTION ***Failure to flex the rocker arm fully while tightening the pump bodies together will result in excessive pump pressure and possible engine flooding or pump diaphragm failure.***

Fuel Filter

Standard models have a serviceable, bowl type fuel filter connected to the inlet of the fuel pump. To service in accordance with the maintenance schedule in the Operator's Manual; remove, empty, clean and dry the sediment bowl (Figure 6-17). Remove the screen and clean any trapped particles. When replacing the sediment bowl, be sure the screen and gasket are in place.

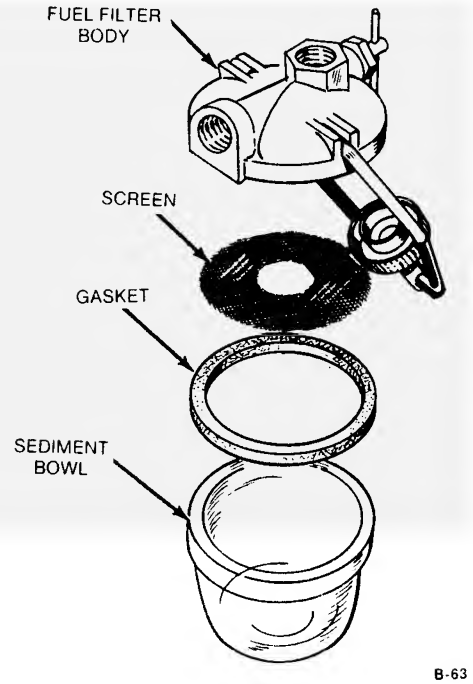


FIGURE 6-17. FUEL FILTER

RV models have a disposable fuel filter connected to the inlet of the fuel pump. Replace according to the maintenance schedule in the Operator's Manual or if it is causing poor performance by restricting fuel flow.

Electric Choke

The choke consists of a bi-metal coil and an electric heating element. The bi-metal coil is connected to the choke shaft so as to rotate it in response to ambient temperature and heat from the electric heating element.

As the engine starts, current is supplied to the electric heating element in the choke cover. Heat from the element causes the bi-metal coil to twist. The twisting action of the coil rotates the choke open. Heat from the element keeps the choke open while the engine is running. See Section 7. Control, for wiring diagrams of typical choke heater connections.

Adjustment: The normal choke setting is approximately 1/8 inch from the fully closed position at an ambient (and engine) temperature of 70° F (21° C). Occasionally, adjustment may be necessary to provide the best fuel-to-air mixture for the prevailing ambient temperatures. Several adjustments may be necessary to arrive at the best setting. Let the engine cool to ambient air temperature between each adjustment. Figure 6-18 illustrates adjustment of the electric choke.

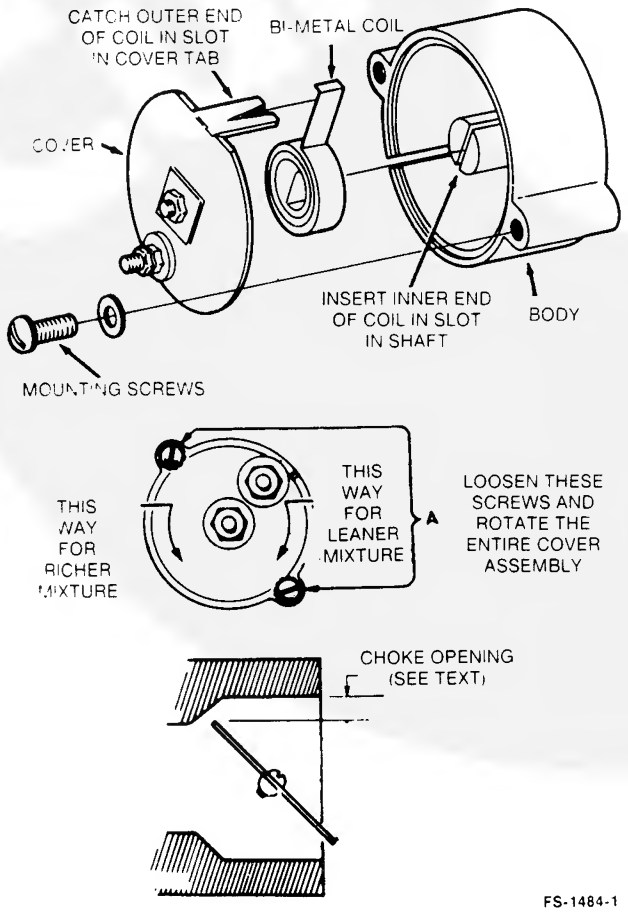


FIGURE 6-18. CHOKE ADJUSTMENTS

If the engine starts, runs for a few minutes, then stops; the choke mixture may be too lean. If the engine starts, but runs rough and is sluggish once it has warmed up; the choke mixture may be too rich.

⚠CAUTION ***The choke cover gets hot during normal operation and can cause burns if touched. Do not touch the choke cover while the engine is operating.***

Loosen the two screws and rotate the choke cover until the correct setting is attained. Check the setting by starting the engine and observing its operation. Be sure to retighten the mounting screws after adjustment.

Repair: If the choke fails to operate, check to see that the heating element is working. If it is, the choke cover should become hot after a few minutes of engine operation. If the cover does not get hot, check for current at the cover terminal. Trace down any opens or shorts.

Remove the choke cover to inspect the heating element and coil. See that the element is not burned out or broken. The bi-metal coil must not be damaged, bind in the housing, or have an improperly directed spiral.

Gas Demand Regulator

A gas demand regulator is provided for gas fuel and combination gas/gasoline fuel generator sets (Figure 6-19). In conjunction with the carburetor, it provides the correct fuel-to-air ratio over the full range of operation. The procedure for adjusting the gas carburetor is the same as for gasoline carburetors.

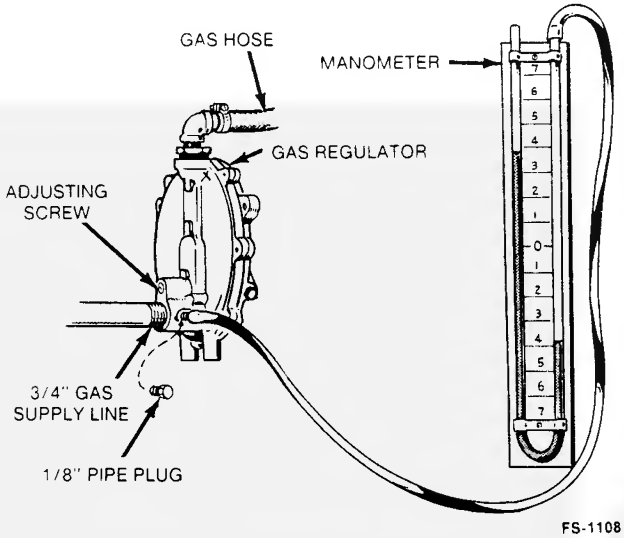


FIGURE 6-19. GAS DEMAND REGULATOR LOCK-OFF ADJUSTMENT

The regulator is factory adjusted to lock-off at an inlet gas supply pressure of 7 inches water column (WC). A gas supply pressure of at least 3.5 inches WC is required for the regulator to operate. A gas pressure regulator must be provided if the supply gas pressure exceeds 14 inches WC.

If the gas supply pressure exceeds 7 inches WC, adjust the regulator as follows:

1. Connect a manometer that can indicate up to 14 inches WC to the 1/8 inch pipe tap as shown in Figure 6-19.
2. Turn on the gas shutoff valve in the gas supply line and disconnect the hose to the carburetor.
3. Alternately cover and uncover the outlet of the regulator with your hand and watch the manometer.
4. The manometer will hold steady if the regulator is locking-off as required each time your hand is removed. Turn adjusting screw G just far enough to obtain a steady reading if the pressure drops when your hand is removed.
5. Operate the engine to make sure that it starts reliably.

⚠CAUTION ***The soap bubble method of testing is not sensitive enough. A manometer must be used to verify complete lock-off of the regulator.***

RECOIL STARTER

Service of the recoil starter, on models so equipped, involves disassembly to replace a broken recoil spring or rope, adjust pre-tension if the recoil spring is weak or to clean up gummed-up or broken internal parts. The starter must be aligned with the engine to engage properly and prevent breakage of parts. Observe the following procedures.

Installation: Follow each step below in sequence, referring to Figure 6-20.

1. Remove flywheel screw 23. Leave the existing rope sheave in place. The sheave provides easier emergency cranking than the starter cup.
2. Secure cup 2 by placing lock washer 26 and flat washer 24 between the cup and cap screw 23.
3. Install the starter assembly on the engine housing, aligning centering pin 19 with the hole in flywheel capscrew head 23. Pull the centering pin out farther with a pair of pliers if it does not engage the hole in the screw head. Use the set of three washers and screws 21 and 25 to secure the assembly to the housing. There must be a clearance of approximately 1/8 inch between cup 2 and rotor face 17, and 3/32 inch between capscrew 23 and the starter shaft.

⚠CAUTION ***Incorrect alignment can damage the starter assembly.***

4. Start the engine with the starter to check the installation. When using the starter, it is recommended that six inches of cord be pulled out slowly before giving a fast steady pull to start the engine. The slack could prevent cord breakage if the engine backfires.

Starter Dissembly:

1. Hold down washer 7 by hand and remove retainer ring 6. Let up on washer 7 carefully so that spring 8 does not fly off. Remove brake spring 8, washers 9 and 10 and friction shoe assembly parts 11, 12, 13 and 14.
2. Hold the cord and cover as shown in window D of Figure 6-20 and remove the screws holding mounting ring 3 and flange 5. Allow cord rewind spring 18 to unwind slowly.
3. To prevent the recoil spring from escaping wildly, pry rotor 17 about 1/4 inch away from cover 20 and detach recoil spring 18 from the rotor. Then remove the rotor.

⚠CAUTION ***The recoil spring can cause injury if allowed to escape wildly. Wear safety glasses and follow disassembly instructions carefully.***

4. Unwind the recoil spring from the housing one coil at a time.
5. Cut out a broken or frayed cord from the rotor.
6. Clean all the parts thoroughly.

Starter Assembly:

1. Rewind recoil spring 18 in housing 20. Make sure that the hook on the outside of the spring engages the pin in the housing, and that the spring is coiled in the right direction (Window G, Figure 6-20). Lubricate the spring and shaft with a few drops of SAE 20 or 30 oil. For extremely dusty service use powdered graphite. Avoid getting lubricant on brake washers 9 and 10.
2. Tie a single knot in one end of starter cord 16 (window F, Figure 6-20).
3. Thread the other end through the hole in the side of rotor 17 and out into the cord groove.
4. Wind the cord onto the rotor, thread on handle 15 and tie two knots.
5. Place the rotor onto the shaft of cover 20 and engage recoil spring 18 with a slender screwdriver or other tool. Keep a slight tension on the spring by turning the rotor to prevent disengagement while completing the assembly.
6. Replace washers 9 and 10, friction shoe assembly parts 11, 12, 13 and 14, spring 8, large washer 7 and retainer ring 6.
7. With the cord wound on the rotor in the proper direction (Window F, Figure 6-20), turn the rotor and cord two turns for cord pre-tension. Additional turns may be necessary if the spring is weak.
8. Holding the rotor in place, install flange 5 and mounting ring 3 with the mounting screws.

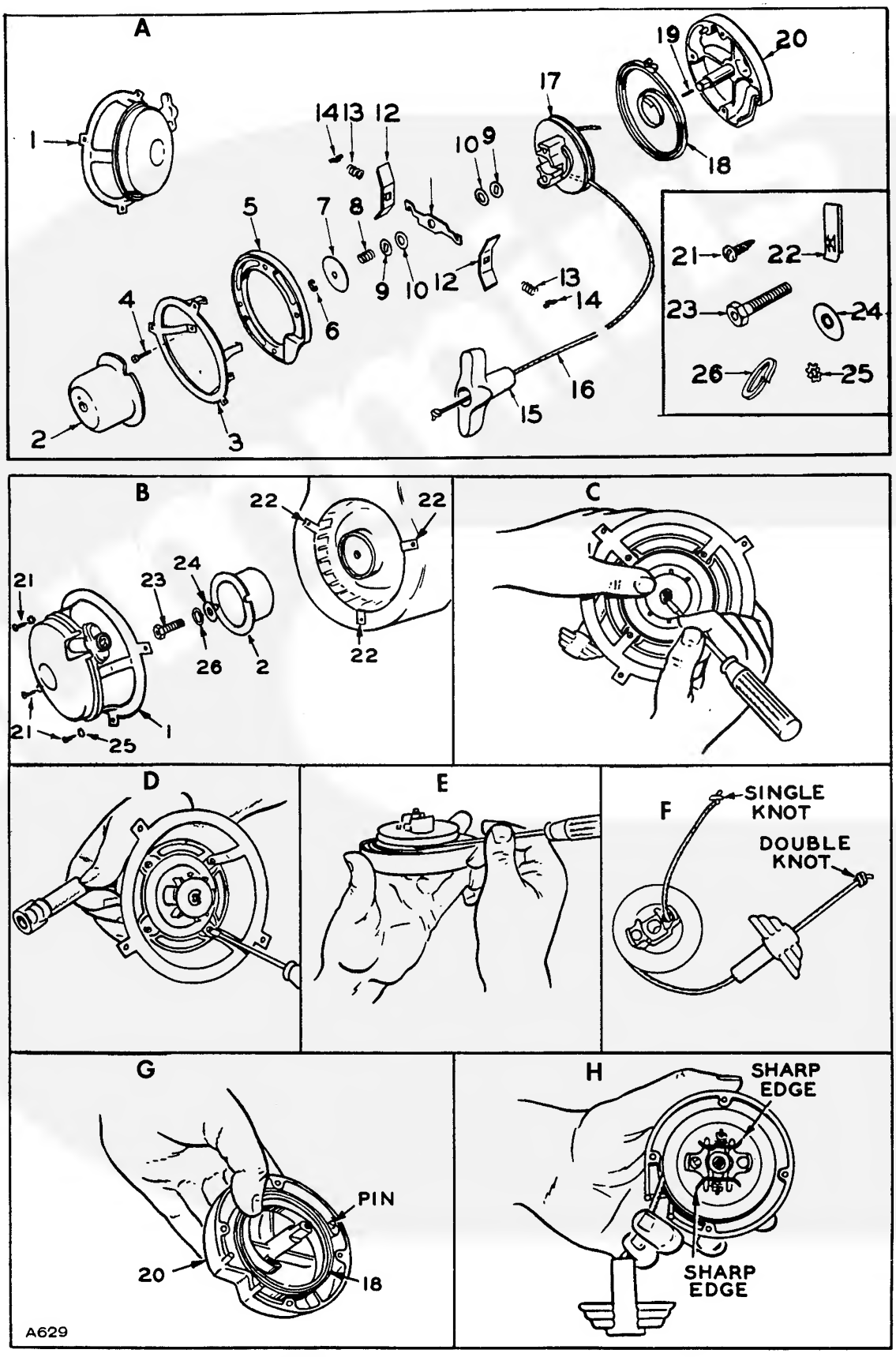


FIGURE 6-20. SERVICING THE RECOIL STARTER

Section 7. Control

MANUAL START AC MODELS

Manual start models are equipped with a stop button on the blower housing and a manual choke. Low oil pressure and momentary contact ignition cutout switch are optional. The AC output is connected directly to two or four power receptacles in a junction box mounted on the set (Figure 7-1).

1800 rpm models

1800 RPM models are equipped with anti-flicker breaker points mounted on the service side of the engine and operated by the camshaft. The points are connected across a resistor which is in series with the field shunt winding of the generator. The points are open during the power stroke and closed during the rest of the engine cycle. Field current is higher when the points are closed, bypassing the resistor. As a result, the generator field is stronger between power strokes while the generator is slowing down, and weaker during the power stroke when it is speeding up. Fluctuation of the output voltage, noticeable as light flicker, because of slow-down between power strokes, is thereby reduced (Figures 7-2 and 7-3). A capacitor is connected across the points to reduce sparking and consequent pitting of the points.

Inspect and adjust the points to Specifications. Badly pitted points are an indication of a defective capacitor, which should be replaced. If lights flicker after the points have been serviced, the resistor is probably defective and should be replaced.

MODELS WITH THE AUTOMATIC IDLE DEVICE

Refer to Governor Adjustments: Standard AC Models, in Section 6, for a description of the automatic idle device. The device is controlled by a transformer and relay in the power outlet junction box (Figures 7-4 and 7-5). The power output of the generator passes through the primary windings of the transformer. The idle control relay is energized by the secondary windings of the transformer. When the output drops below 100 watts, the idle control relay drops out, energizing the solenoid in the idle device, which overrides the governor to reduce engine speed to about 1800 RPM. The idle control switch on the side of the junction box allows the operator to disconnect the idle solenoid from the relay so that it will not function.

STANDARD REMOTE START AC MODELS

These models are equipped with a control box mounted on top of the generator (Figure 7-6). The control box includes a start/stop switch, starter solenoid, start disconnect relay, battery charging resistor, terminals for remote control wiring connections, connections for the automatic choke electric heater and the AC output pigtails. A low oil pressure ignition cutout switch, a momentary contact ignition shutoff switch and a high temperature ignition cutout switch are available as options (Figures 7-7 and 7-8). Figure 7-7 is representative of 120 or 240 V two wire models, and Figure 7-8 of 120/240 V three wire models.

When the start/stop or remote control switch is turned on, the starter solenoid is energized by the battery. Current flows through the generator which causes it to turn like a motor to start the engine. When generator output reaches a certain value, the start disconnect relay drops out the starter solenoid and connects the series field winding through the resistor to recharge the battery. The generator set will continue to run until the start/stop or remote control switch is turned off.

The electric choke heater is energized while the engine is running. The low oil pressure and high temperature cutout switches ground the primary coil of the magneto to shutoff the engine when oil pressure drops or temperature rises to the calibrated value of the switch.

BATTERY CHARGER MODELS

These models are equipped with a control box mounted on top of the generator (Figure 7-6). The control box includes a start/stop switch, starter solenoid, battery charging diode and heat sink assembly, battery charging ammeter, terminals for remote control wiring connections, connections for the automatic choke electric heater and terminals for the battery cables (Figure 7-9). A high temperature cutout switch is optional.

When the start/stop or remote control switch is turned on, the starter solenoid is energized. Current flows through the generator from the battery or bank of batteries being charged, causing it to turn like a motor to start the engine. The starter solenoid is kept energized during operation to maintain the connection between the battery and generator. As the generator reaches operating speed, generator voltage builds up to the point where it exceeds battery voltage, causing the current to reverse. The reverse current recharges the battery. The ammeter indicates the level of the charging current. The diode assembly prevents the battery from being discharged through the generator when the set is not running.

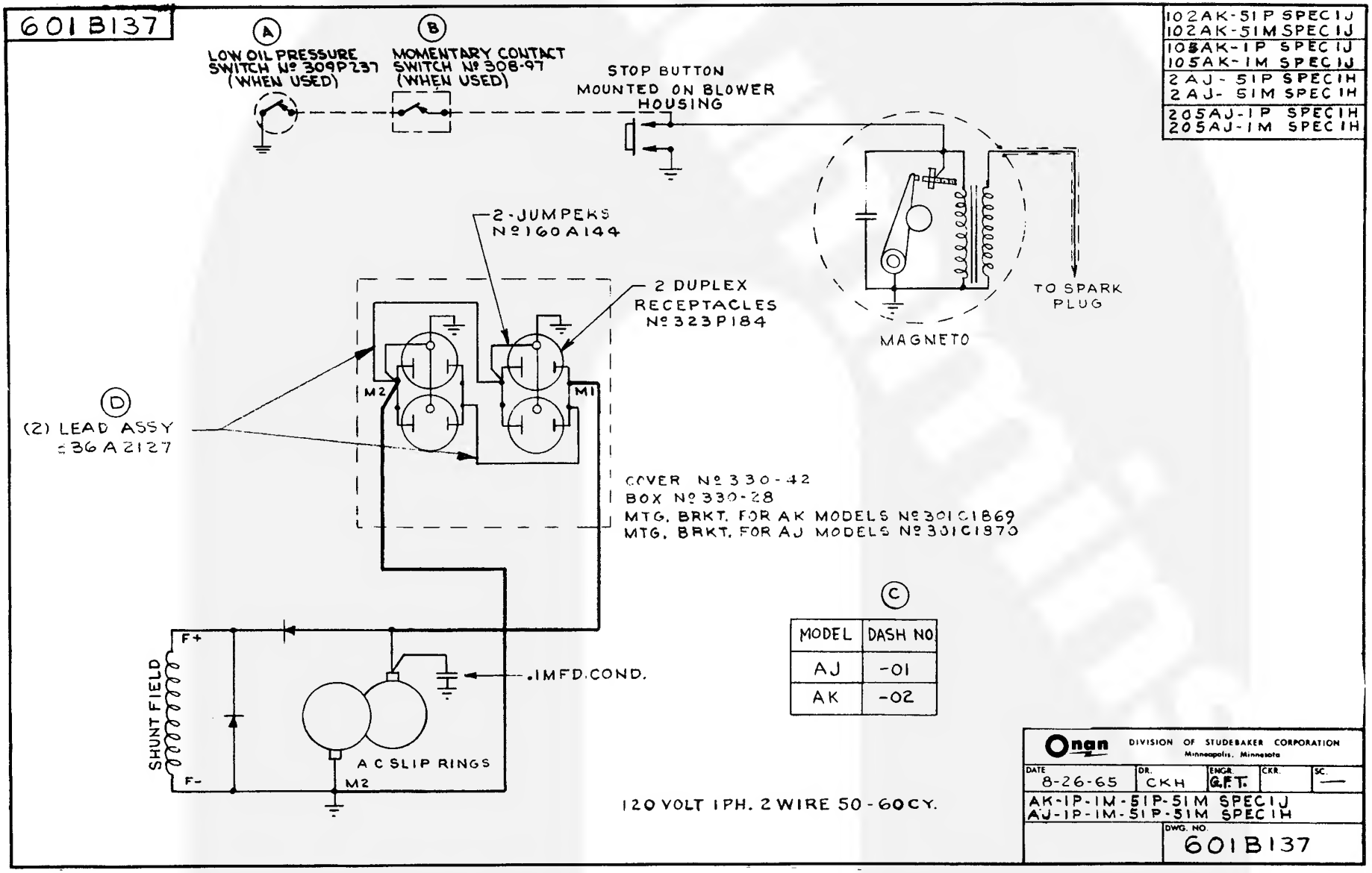


FIGURE 7-1. MANUAL START AC MODELS

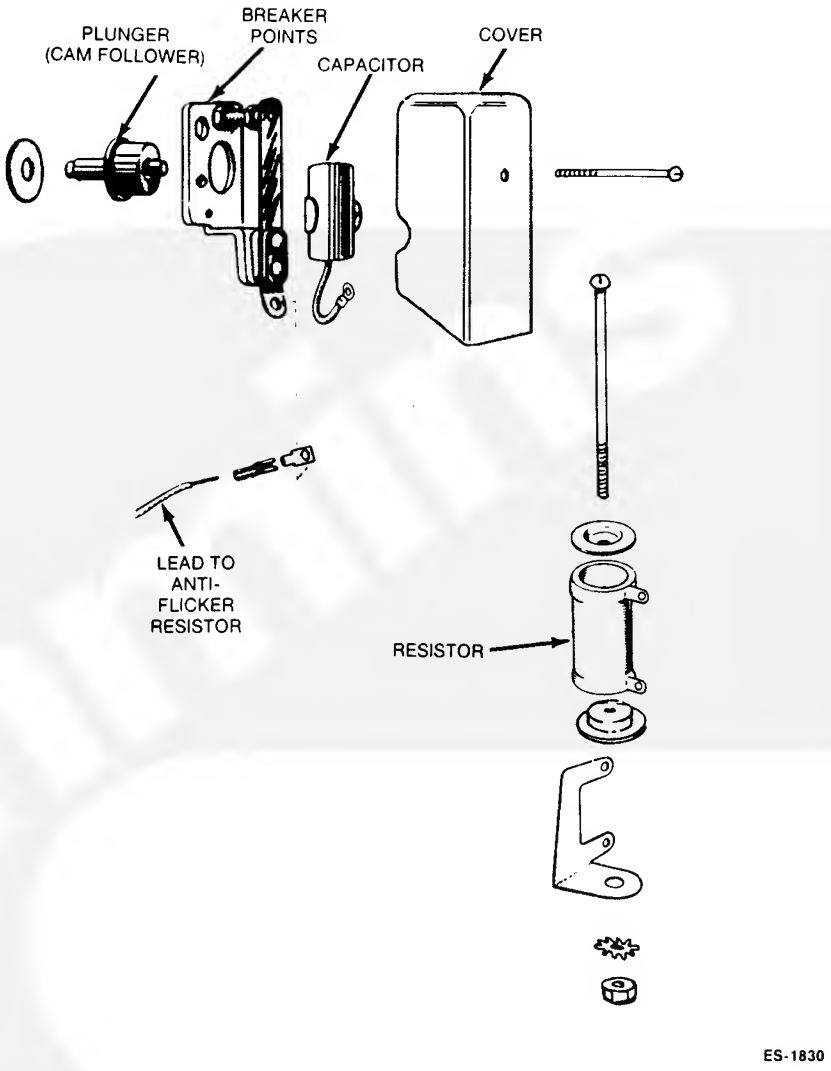


FIGURE 7-2. ANTI-FLICKER BREAKER POINTS AND RESISTOR

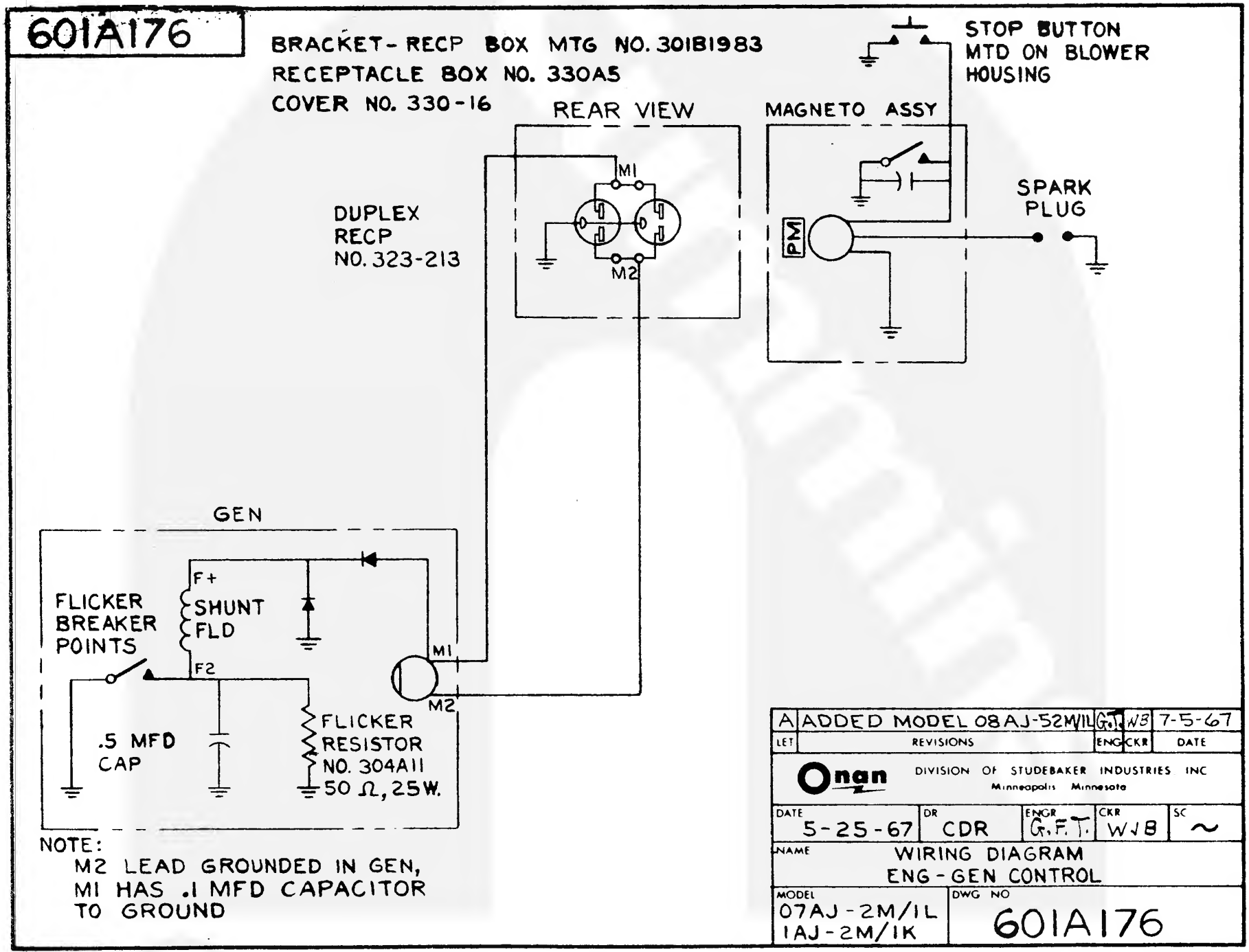


FIGURE 7-3. 1800 RPM MODELS

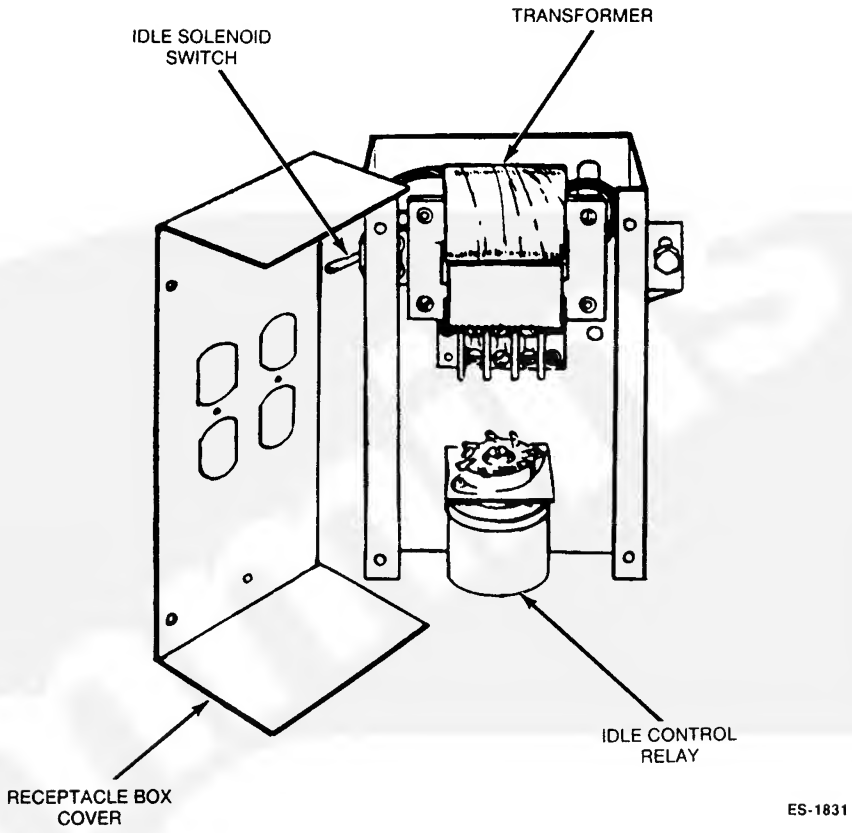


FIGURE 7-4. AUTOMATIC IDLE DEVICE CONTROL

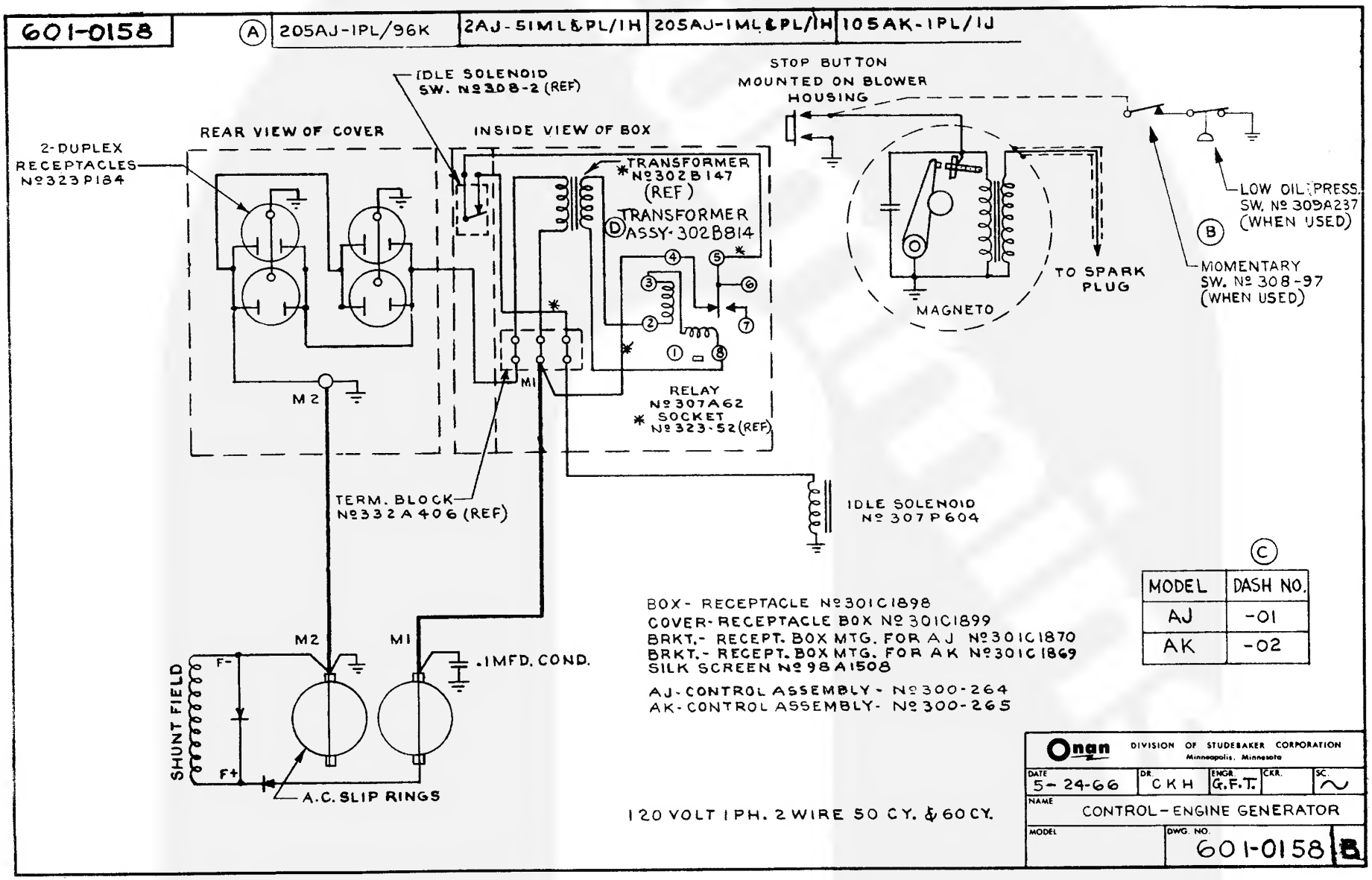


FIGURE 7-5. MODELS WITH THE AUTOMATIC IDLE DEVICE

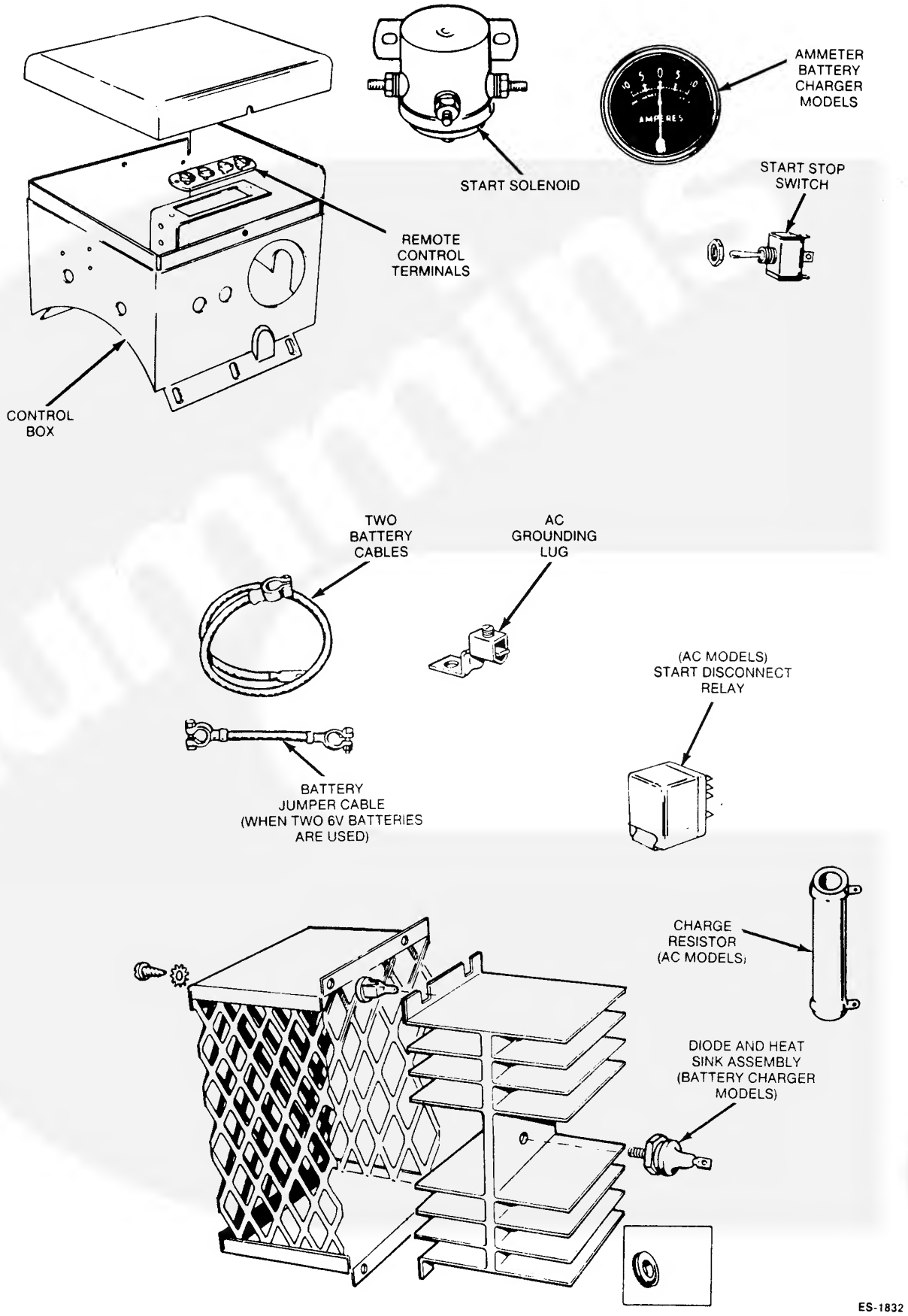
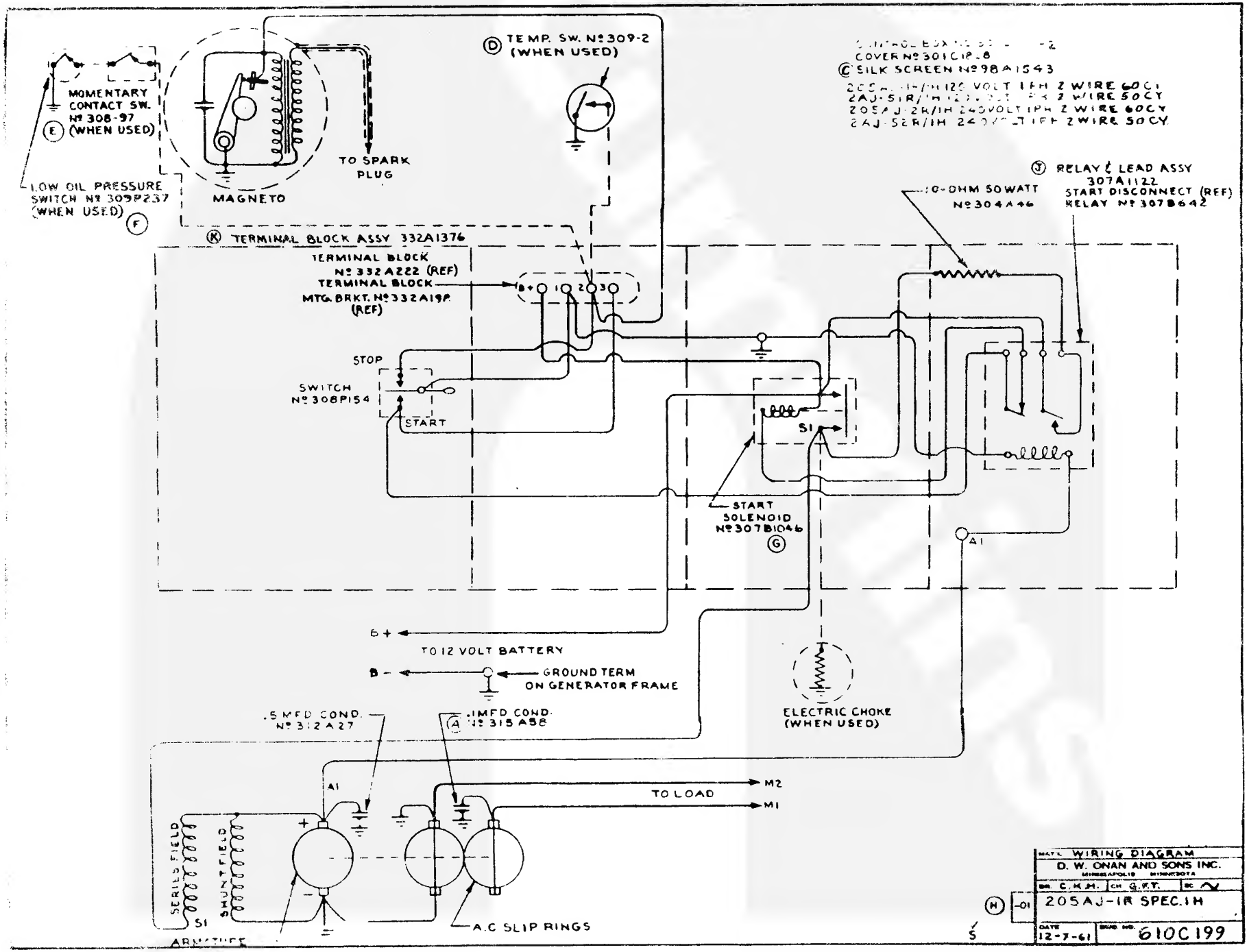


FIGURE 7-6. CONTROL PARTS FOR STANDARD REMOTE START AC MODELS


MOMENTARY CONTACT SW. Nº 308-97 (WHEN USED)
(E)
LOW OIL PRESSURE SWITCH Nº 309P237 (WHEN USED)
(F)
MAGNETO
TO SPARK PLUG
(D) TEMP. SW. Nº 309-2 (WHEN USED)
COVER Nº 301C1P-8
(C) SILK SCREEN Nº 98A1543
(J) RELAY & LEAD ASSY 307A1122
START DISCONNECT (REF) RELAY Nº 307B642
10-OHM 50 WATT Nº 304A46
(K) TERMINAL BLOCK ASSY 332A1376
TERMINAL BLOCK Nº 332A222 (REF)
TERMINAL BLOCK MTG. BRKT. Nº 332A19P (REF)
B+ 1 2 3
STOP
SWITCH Nº 308P154
START
S1
START SOLENOID Nº 307B1046
(G)
A1
B+
TO 12 VOLT BATTERY
B-
GROUND TERM ON GENERATOR FRAME
ELECTRIC CHOKE (WHEN USED)
.5 MFD COND. Nº 312A27
(A) .1 MFD COND. Nº 315A98
A1
TO LOAD
M2
M1
SERIES FIELD
SHUNT FIELD
S1
ARMATURE
A.C SLIP RINGS
(H) -01
205AJ-1R SPEC. 1H
DATE 12-7-61
610C199

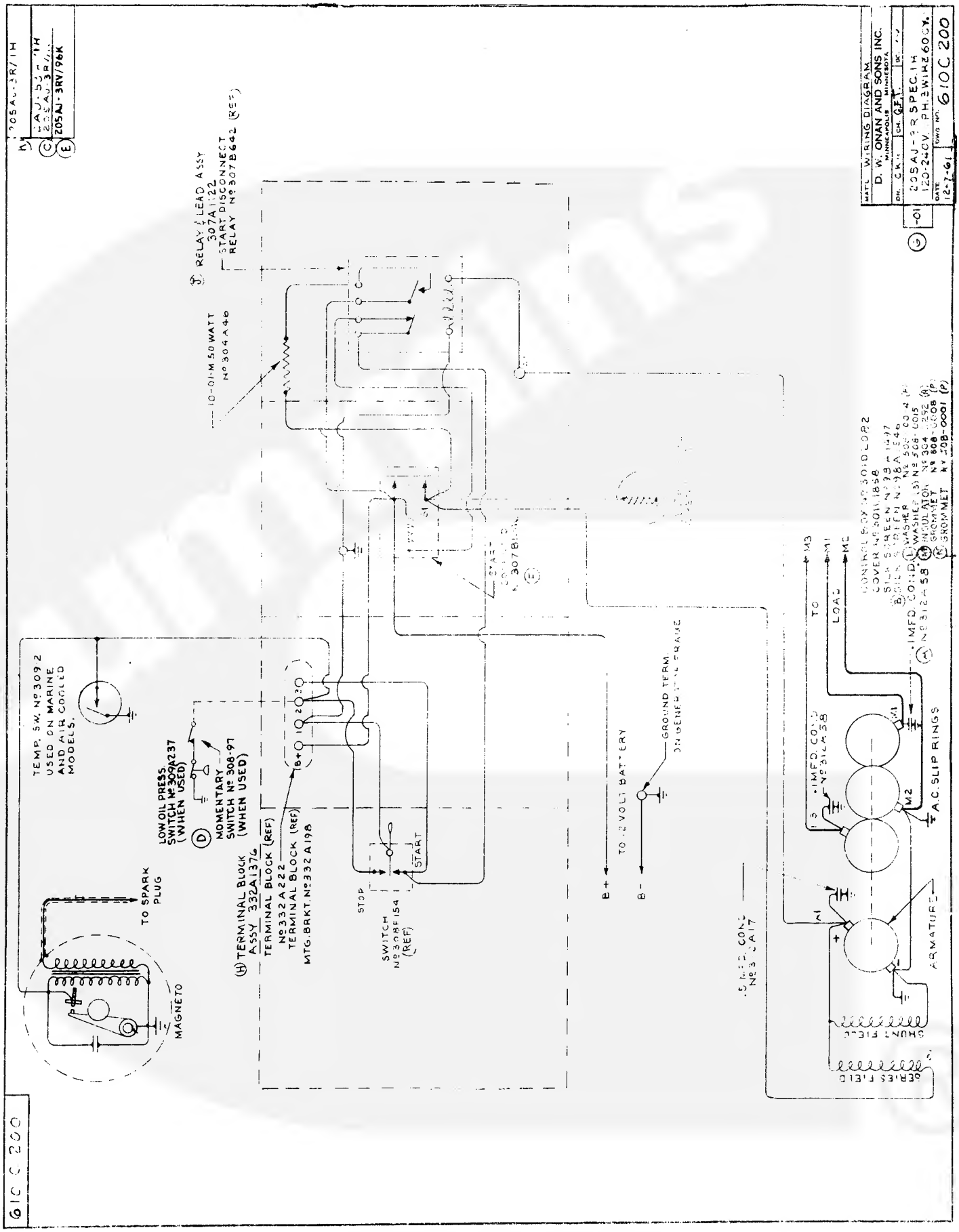
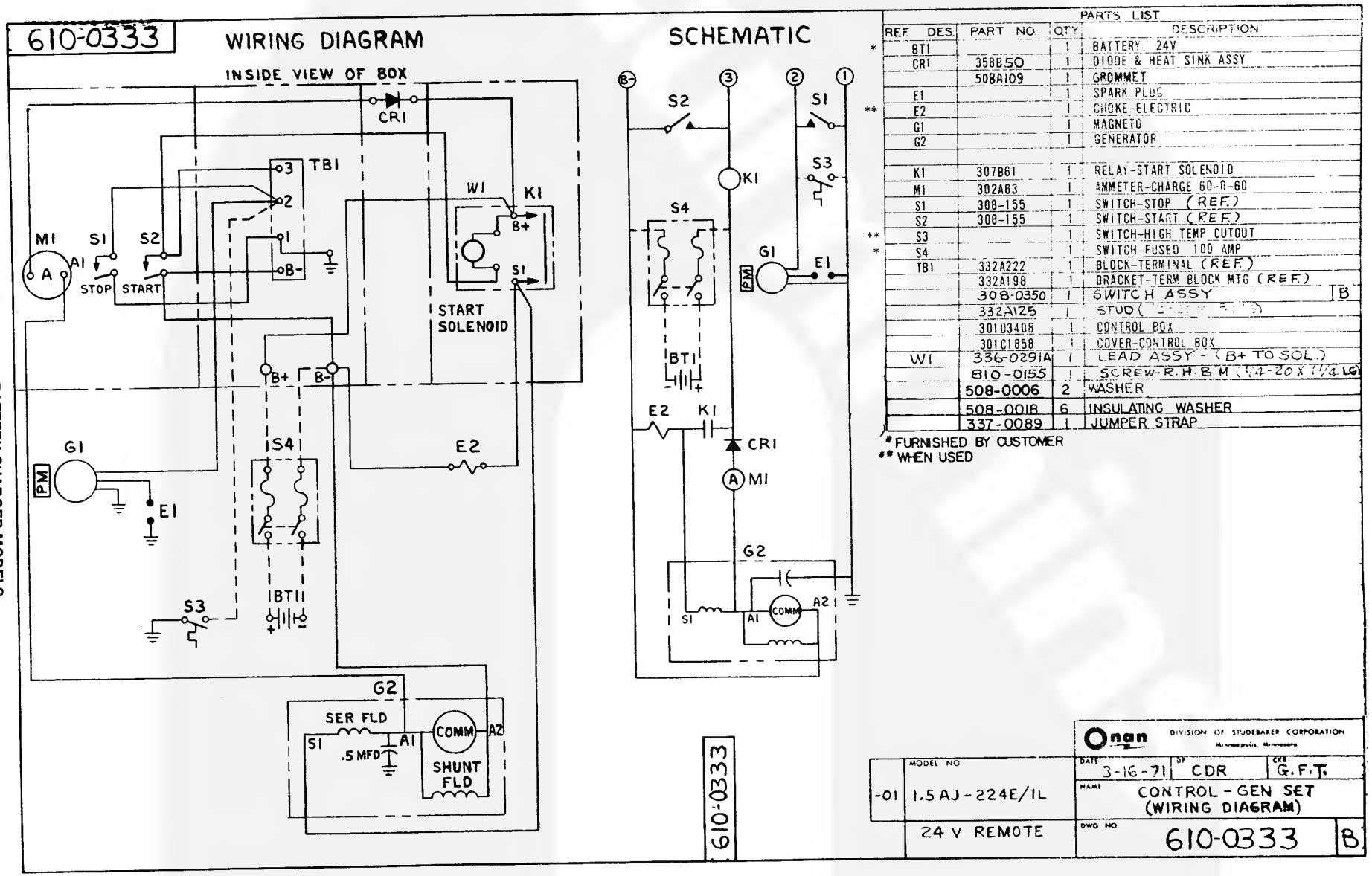


FIGURE 7-8. STANDARD REMOTE START AC MODELS (3 WIRE)



PARTS LIST

	REF. DES.	PART NO.	QTY	DESCRIPTION
*	BT1		1	BATTERY 24V
	CR1	358B50	1	DIODE & HEAT SINK ASSY
		508A109	1	GROMMET
	E1		1	SPARK PLUG
**	E2		1	CHOKE-ELECTRIC
	G1		1	MAGNETO
	G2		1	GENERATOR
	K1	307B61	1	RELAY-START SOLENOID
	M1	302A63	1	AMMETER-CHARGE 60-0-60
	S1	308-155	1	SWITCH-STOP (REF.)
	S2	308-155	1	SWITCH-START (REF.)
**	S3		1	SWITCH-HIGH TEMP CUTOUT
*	S4		1	SWITCH FUSED 100 AMP
	TB1	332A222	1	BLOCK-TERMINAL (REF.)
		332A198	1	BRACKET-TERM BLOCK MTG (REF.)
		308-0350	1	SWITCH ASSY B
		332A125	1	STUD ( )
		301U3406	1	CONTROL BOX
		301C1858	1	COVER-CONTROL BOX
	W1	336-0291A	1	LEAD ASSY - (B+ TO SOL.)
		810-0155	1	SCREW-R.H.B.M. (1/4-20 X 1 1/4 LG)
		508-0006	2	WASHER
		508-0018	6	INSULATING WASHER
		337-0089	1	JUMPER STRAP

*FURNISHED BY CUSTOMER
**WHEN USED

Onan DIVISION OF STUDEBAKER CORPORATION Minneapolis, Minnesota

	MODEL NO	DATE	BY	CKD
-01	1.5AJ-224E/1L	3-16-71	CDR	G.F.T.
	24 V REMOTE	NAME: CONTROL - GEN SET (WIRING DIAGRAM)		
		DWG NO: 610-0333		B

FIGURE 7-9. BATTERY CHARGER MODELS

RV MODELS

RV models are equipped with a control box and a separate junction box with circuit breaker for the AC output pigtails (Figures 7-10 and 7-11). The control box includes start/stop switch S1, control fuses F1 and F2, starter solenoid K1, relays K2, K3 and K4, resistor R1 and the internal wiring harness which includes diode CR1 and a receptacle for remote control connections. The battery charging resistor R2 is mounted in the engine bell housing. The control box is connected by wiring to automatic choke, ignition coil, fuel shutoff solenoid, low oil pressure ignition cutoff switch and generator start windings.

These models operate as follows:

1. When start switch S1 is pressed to ON, starter solenoid K1 and ignition crank relay K2 are energized.
2. K1 connects the generator and electric choke to the battery for starting.
3. K2 connects the ignition coil and fuel solenoid to the battery so that ignition spark and fuel are available as the engine starts to turn.
4. The engine should start and run up to normal operating speed in a matter of seconds.
5. The low oil pressure ignition cutout switch should close after a few revolutions of the engine, energizing relays K3 and K4.
6. Relay K3 opens the circuit to relay K1, which drops out, disconnecting the generator starter windings from the battery.
7. When start switch S1 is released, the switch opens, causing relay K2 to drop out, disconnecting the ignition crank circuit.
8. The engine will continue to run when the start switch is released if relay K3 has closed (engine oil pressure is normal).
9. Relays K3 and K4 are energized by the 12 volt battery during cranking and by the output of the generator field series winding (approximately 30 volts) while the set is running. Relays K3 and K4 have 12 volt operating coils. When relay K4 is energized, the bypass around terminals 2 and 3 of resistor R1 is opened. The added resistance in the circuit reduces voltage across the relay coils from 30 to 12 volts.
10. The battery is recharged through resistor R2 and diode CR1. The diode prevents the battery from being discharged through the generator when the set is not operating.
11. The set is stopped by pressing stop switch S1 to OFF. The stop switch grounds the series field winding, de-energizing relay K3, which opens the ignition and fuel circuits.

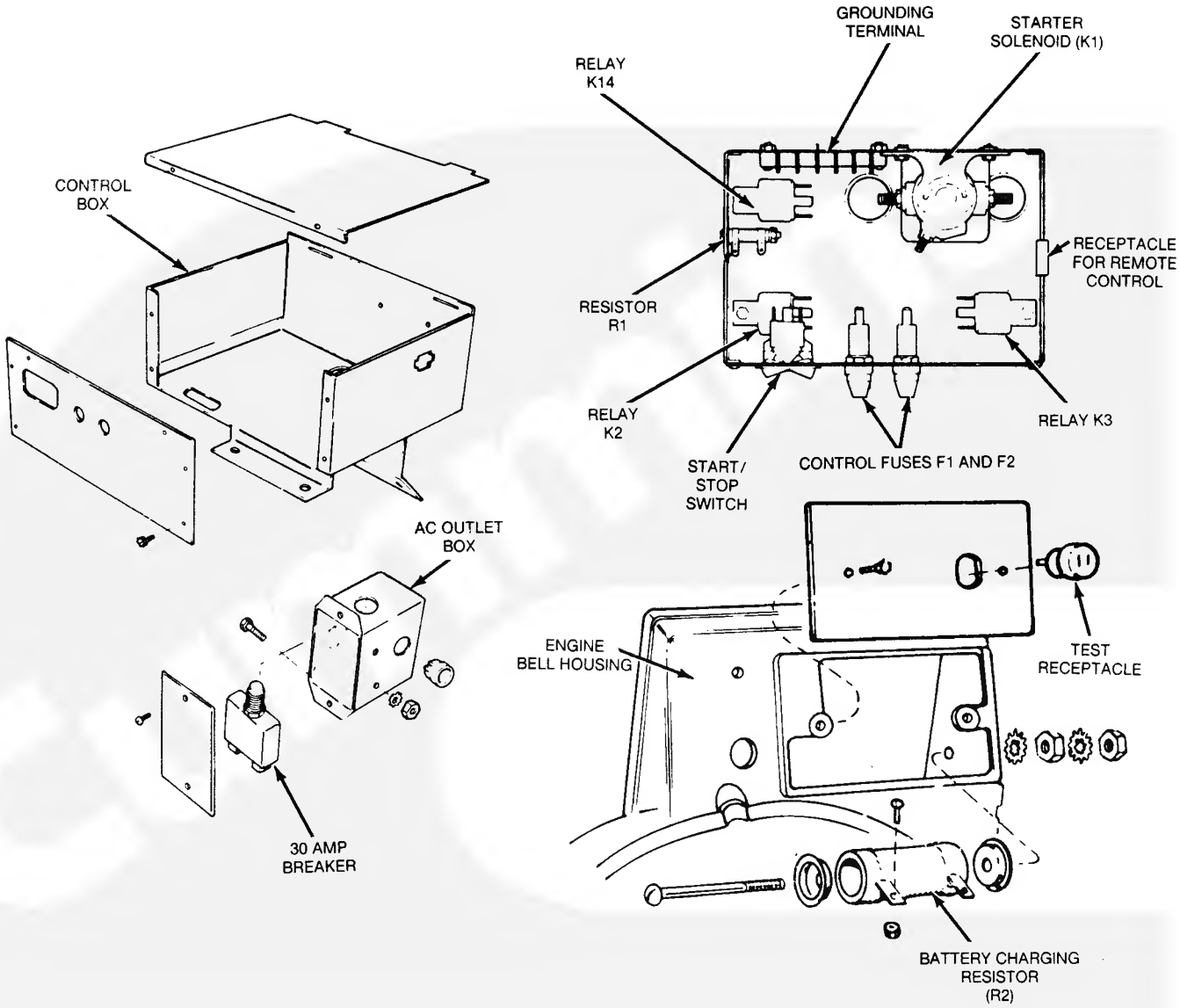
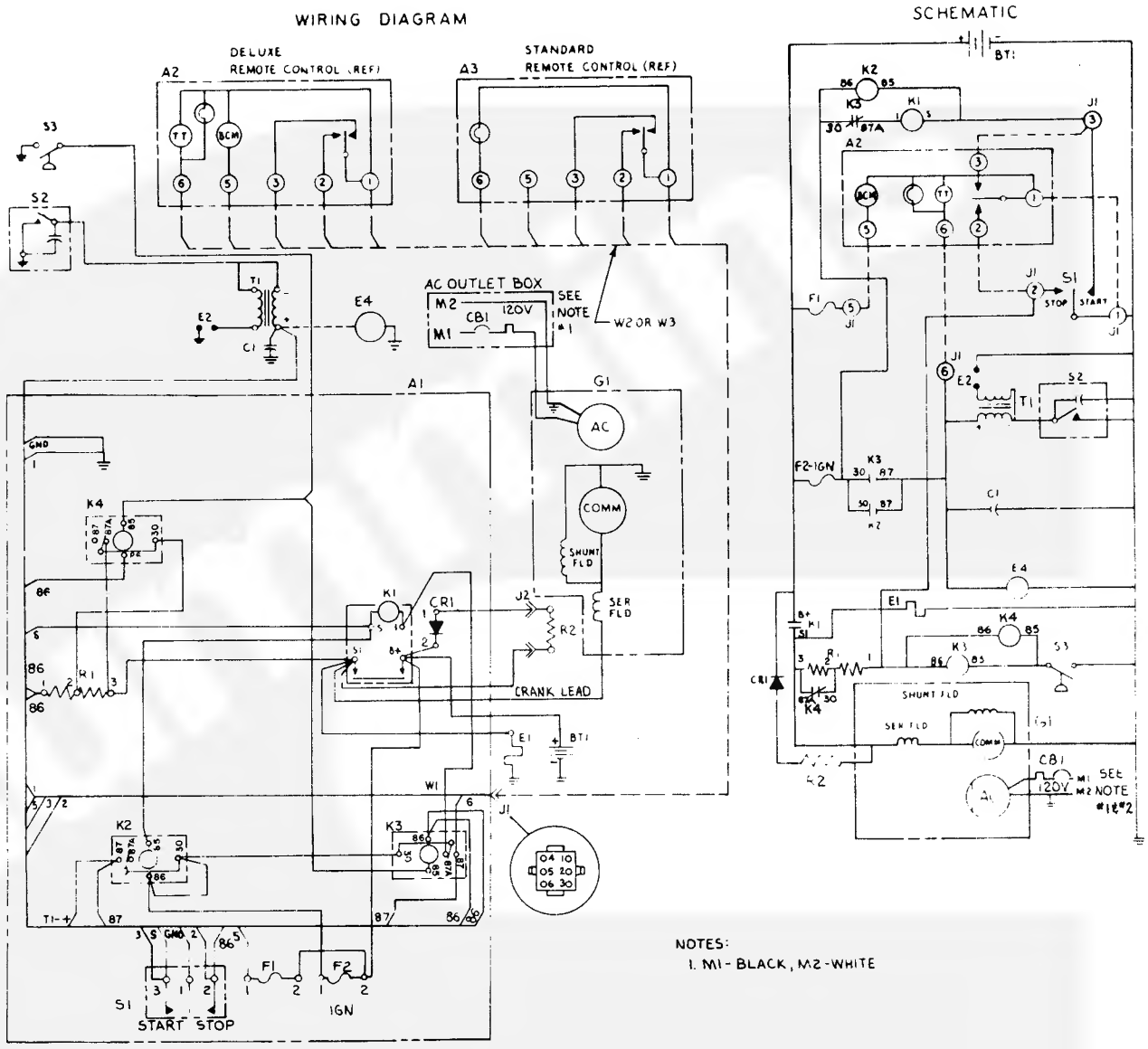


FIGURE 7-10. RV MODEL CONTROL PARTS



A1 ..... Control Assembly	E2 ..... Spark Plug
A2 ..... Deluxe Remote Control	E4 ..... Fuel Shut Off Solenoid
A3 ..... Standard Remote Control	T1 ..... Ignition Coil
S1 ..... Start-Stop Switch	S2 ..... Breaker Points Assembly
F1, F2 ..... Fuse (5-amp, 32 Volt)	S3 ..... Switch - Low Oil Pressure
K1 ..... Start Solenoid	G1 ..... Generator
K2 ..... Relay-Crank Ignition	CB1 ..... 30 Amp Circuit Breaker
K3 ..... Relay-Run Igniton	R2 ..... Resistor (10-Ohm, 45 Watt)
E1 ..... Choke - Onan	BT1 ..... Battery - 12 Volt

FIGURE 7-11. CONTROL SYSTEM SCHEMATIC

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLESHOOTING THE CONTROL

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Starts But Stops When Start Switch is Released	1. Low oil pressure switch not closing due to: a. low oil level, b. open circuit between switch and control, c. defective low oil pressure switch, or d. low oil pressure. 2. Output voltage from generator not being supplied to control due to: a. open circuit in wiring between generator and control b. no output voltage from generator.	1a. Check oil level and add oil if low. 1b. Check for continuity and correct if circuit is open. 1c. Replace low oil pressure switch. 1d. Refer to Lubrication system section for test and service procedures. 2a. Check for continuity and correct if circuit is open. 2b. Refer to Generator section for test and service procedures.
Engine Starts And Runs; Then Stops. Set Restarts Immediately or Set Restarts After Cooling Down	1. Fuel level is below generator set fuel pickup tube or oil level is low. 2. Faulty choke operation due to sticking choke linkage, incorrect choke adjustment, open circuit in wiring between choke heater and generator, or defective choke heater. 3. Vapor lock due to: a. high ambient air temperatures or b. faulty fuel pump c. faulty fuel solenoid. 4. Breaker points sticking. 5. Contaminated fuel.	1. Check fuel and oil levels and refill as necessary. 2. Refer to *Fuel System* section for testing and service procedures. 3a. Refer to *Cooling System* section. 3b. Refer to *Fuel System* section for test and service procedures. 4. Replace breaker points. 5. Refill tank with fresh fuel.
Low Battery	1. Weak or discharged battery. 2. Load connected to battery while set is turned off. 3. Open in charge circuit due to: a. open charging diode (CR1). b. open charge resistor (R2)	1. Connect a separate battery charger to bring battery up to full charge or replace. 2. Turn off load. 3a. Replace CR1. 3b. Replace (R2)

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLESHOOTING THE CONTROL (Continued)

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
Engine Does Not Crank	1. If engine cranks at set but not at remote control panel, fault is due to: a. open circuit in remote control wiring or b. remote start switch faulty.	1a. Check for continuity and correct if circuit is open. 1b. Replace remote start control switch.
	2. If engine cranks at remote control panel but not at set, fault is due to faulty S1 switch.	2. Replace S1 switch.
	3. Insufficient voltage for cranking due to: a. battery not charged or b. terminal connections loose or dirty.	3a. Check condition of battery and recharge or replace. 3b. Clean and tighten all connections at battery and K1 start solenoid. ⚠WARNING ***Short circuiting the battery cables can result in severe personal injury. Disconnect the negative battery (-) cable at the battery terminal before servicing.***
	4. Control fuse (F2) is open.	4. Replace fuse (5 ampere).
	5. Connect a voltmeter across the coil of the start solenoid. Check for voltage when S1 is placed in Start position. If voltage is present, fault is due to: a. defective K1 relay or b. defective generator.	5a. Replace K1. 5b. Refer to *Generator* section for test and service procedures.
	6. If voltage is not present as described in step 5 test, fault is probably due to: a. open circuit between K1 relay and start switch or b. defective start switch.	6a. Check for continuity and correct if circuit is open. 6b. Replace start switch.
Engine Cranks But Does Not Start	1. Faulty ignition due to worn or fouled spark plugs, magneto malfunction, worn ignition points, incorrect ignition timing, or faulty plug wires.	1. Refer to *Ignition System* section for test and service procedures.
	2. Faulty fuel system due to sticking choke, faulty fuel pump, or carburetor mixture screws incorrectly adjusted.	2. Refer to *Fuel System* section for test and service procedures.

Section 8. Generator

GENERAL

These are revolving armature, self-excited, inherently regulated, self-limiting, single phase, unity power factor, 2-pole generators (except 1800 RPM models, which are 4-pole). The armature rotor is driven directly by the engine through a taper fit with the crankshaft. There are two styles: Standard and RV. Figures 8-1 and 8-2 illustrate the two styles.

BASIC OPERATION

The engine governor holds the rated speed (frequency) by adjusting the throttle as the load changes (as lights, motors, etc. are turned on and off). The output voltage is inherently regulated by the design of the generator. This is accomplished by running with the iron core of the field magnetically saturated. As a result, increasing the field current above a certain level does not increase the strength of the magnetic field, effectively limiting the output voltage. A voltage regulator is therefore not used. The generator is also self-limiting by design, since output voltage falls off if too much load is connected (including a dead short across the output), effectively protecting the generator windings from overheating.

Manual Start Models

The armature windings are connected to the AC load through a set of slip rings and brushes (Figure 7-1) The field is energized by a shunt winding (connected in parallel with the load). A diode converts the field current to half wave DC (The generator would not otherwise work since the field polarity would keep changing each cycle). The generator is self-exciting because of residual magnetism in the field poles. As soon as the armature starts turning, the windings cross the residual field, inducing current flow in the windings. Current shunted to the field windings builds up the field, which makes possible a higher output voltage. In a matter of seconds, engine speed and generator voltage stabilize at their pre-adjusted (rated) values.

Electric Start Models

Basic construction and operation are the same as for manual start models except that the armature includes a separate exciter/starter winding and commutator and the field series as well as shunt winding (Figures 7-7 and 7-8). To start the engine, a 12 volt battery (or two 6 volt batteries in series) is connected to the series winding of the generator field by means of a starter solenoid. Current flows through both field windings and the starter/exciter winding on the armature, motorizing the generator to turn the engine. After the engine starts and the battery has been disconnected, the starter/exciter winding and commutator provide full wave DC to energize the field. The main armature windings are connected to the AC load through a set of slip rings and brushes.

Battery Charger Models

Basic construction and operation are the same as for electric start models except that the armature does not include AC windings and slip rings (Figure 7-9). The battery or bank of batteries being charged is used to energize the generator to start the engine.

RV Models

RV models operate the same way as electric start models, although different in construction (Figure 7-11).

1800 RPM Models

These models have a 4-pole field and anti-flicker breaker points and resistor. The anti-flicker breaker points are mounted on the service side of the engine and operated by the camshaft. The points are connected across a resistor which is in series with the field shunt winding of the generator. The points are open during the power stroke and closed during the rest of the engine cycle. Field current is higher when the points are closed, bypassing the resistor. As a result, the generator field is stronger between power strokes while the generator is slowing down, and weaker during the power stroke when it is speeding up. Fluctuation of the output voltage, noticeable as light flicker, because of slow-down between power strokes, is thereby reduced (Figures 7-1 and 7-2). A capacitor is connected across the points to reduce sparking and consequent pitting of the points.

GENERATOR TROUBLESHOOTING

Use the following guide to help locate problems related to the generator.

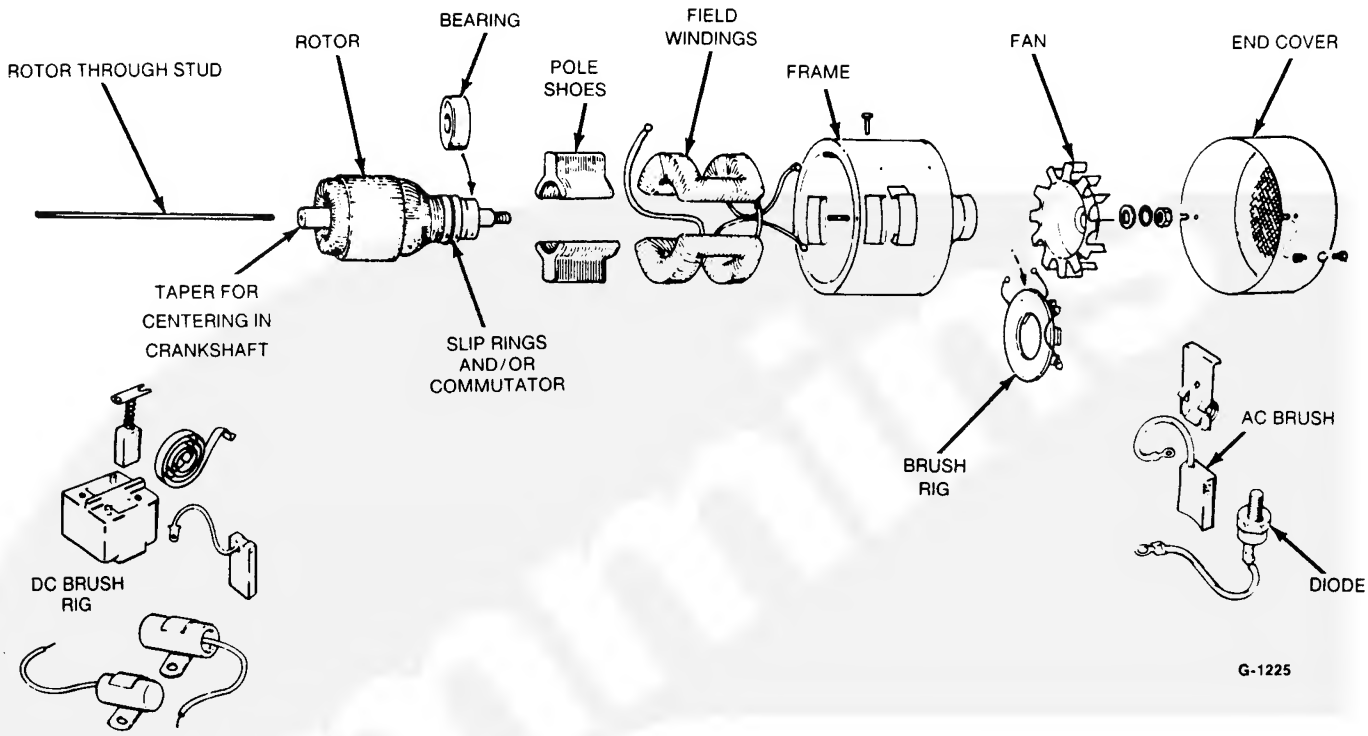


FIGURE 8-1. STANDARD GENERATOR DISASSEMBLED

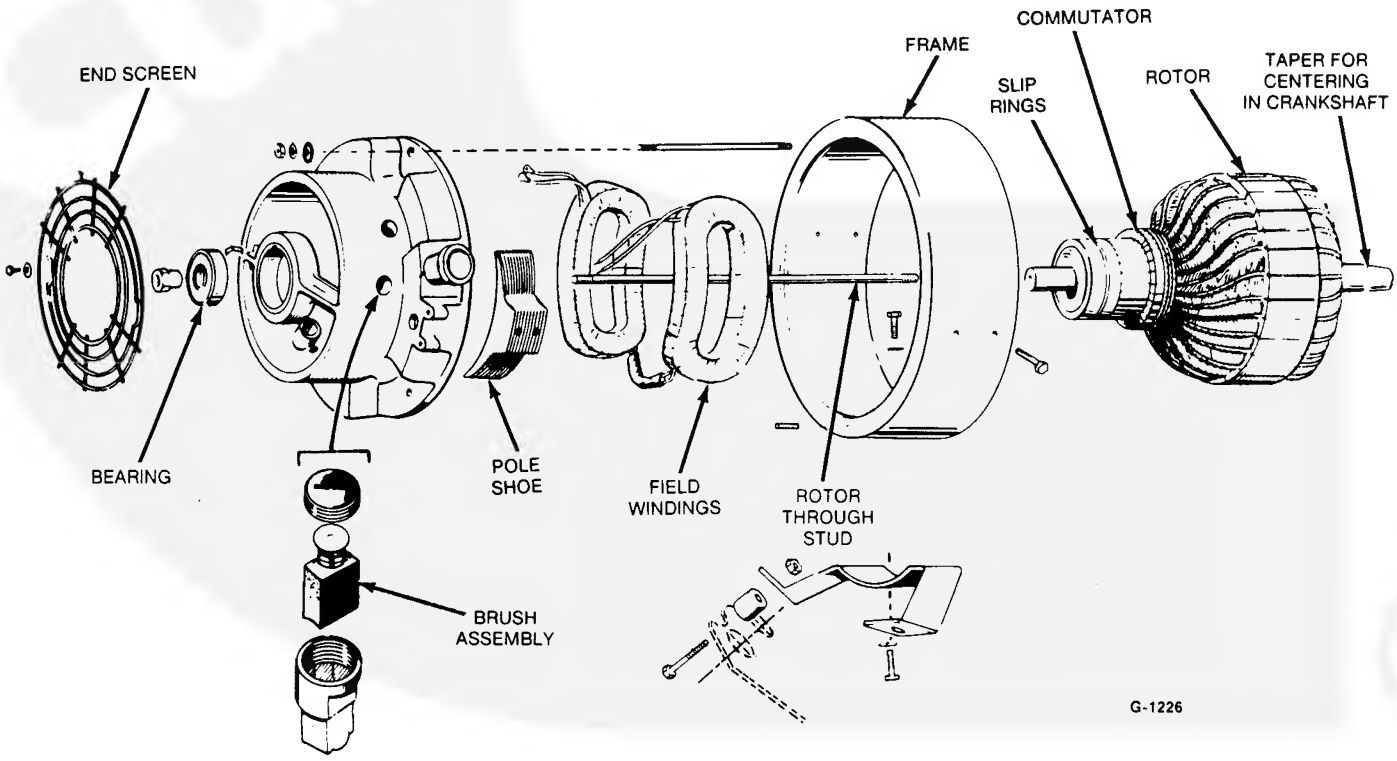


FIGURE 8-2. RV GENERATOR DISASSEMBLED

⚠WARNING ***Many troubleshooting procedures present hazards which can result in severe personal injury or death. Only qualified service personnel with knowledge of fuels, electricity, and machinery hazards should perform service procedures. Review safety precautions on inside cover page.***

TROUBLESHOOTING THE GENERATOR

TROUBLE	POSSIBLE CAUSE	CORRECTIVE ACTION
No AC Voltage	1. Open circuit breaker.	1. Locate cause of overload and correct as required. Reset breaker.
	2. Brushes stuck in holder or not making good contact with slip rings.	2. Release brushes if jammed in holder. Clean slip ring if dirty.
	3. Shorted capacitor.	3. Check and replace if it is defective.
	4. Open, grounded, or short circuited rotor or stator.	4. Test each component for open, grounded, or shorted windings and replace if it is defective.
AC Output Voltage Too Low or Too High	1. Engine governor incorrected adjusted.	1. Refer to *Governor* section.
	2. Defective CR1 bridge rectifier.	2. Test rectifier and replace if it is defective.
	3. Brushes worn or not making good contact with slip rings or commutator.	3. Check length of brushes and replace if worn excessively - clean slip rings if dirty.
	4. Defective capacitor.	4. Check and replace if it is defective.
	5. Defective diode.	5. Check and replace if it is defective.
	6. Open, grounded, or short circuit in rotor or stator.	6. Test each component for open, grounded, or shorted windings and replace if defective.
Noisy Generator	1. Loose brush guide.	1. Tighten brush guide.
	2. Worn generator end bearing.	2. Replace end bearing.
	3. Rotor and stator rubbing together due to varnish lumps.	3. Check for varnish lumps between rotor and stator and remove as required.
Generator Overheats	1. Generator overloaded due to defective circuit breaker.	1. Remove part of load and replace circuit breaker.
	2. Airflow restricted due to obstructed vent openings in stator housing.	2. Clear away all obstructions.
	3. Stator windings covered with oil or dirt.	3. Clean stator windings.
	4. Open, grounded, or short circuited rotor or stator.	4. Test each component for open, grounded, or shorted windings and replace if defective.
	5. Ambient temperature too high.	5. Remove obstructions in room ventilation openings.

GENERATOR SERVICE

Generator Disassembly

1. On sets with mounted fuel tanks, disconnect the fuel line at the fuel pump and drain the fuel out of the tank.

⚠WARNING ***Gasoline is highly flammable. Ignition can cause severe burns or death or destruction of equipment and property by fire or explosion. Store the gasoline in an approved container and keep flames, cigarettes, sparks, equipment with pilot flames, electrical arcs or other ignition sources away.***

2. Disconnect all external electrical load, control and battery connections. The cable on the negative terminal of the battery should be removed from the battery to prevent accidentally shorting the battery while the set is being serviced.
3. Disconnect the low oil pressure cutout, fuel solenoid, electric choke and ignition wires from their respective terminals.
4. Remove the end cover of the generator.
5. Remove all commutator and slip ring brushes.
6. Remove the two generator frame mounting nuts or bolts and carefully pull the generator frame straight back from the engine. The rotor shaft and bearing will remain attached to the engine.
7. Remove the rotor from the engine. The recommended procedure is as follows:

   - Remove the rotor through stud. Unless there are threads in the bore of the rotor shaft, use a 1/2-13 NC tap to cut threads for a length of at least 1 inch (25 mm) in the bore.
   - Insert a steel rod of not more than 1/4 inch (6 mm) diameter into the shaft until it bottoms. Mark the insertion length and cut the rod off about 3/4 inch (18 mm) short, or just short enough so that a bolt can engage at least 4 threads with the rod inserted in the bore.
   - Insert the rod again.
   - Thread a 1/2-13 NC bolt into the bore threads until it bottoms on the rod. Hold the rotor to prevent turning and then turn the bolt with a wrench until the taper fit breaks loose. Pull the rotor away.
8. The field windings are removable from the generator housing by removing the pole shoes, which are each secured by two bolts.
9. Mark the location of the rotor bearing with a sharp scribe and remove it with a suitable gear puller.

⚠CAUTION ***The commutator could be damaged if the jaws of the puller become wedged between the commutator and the bearing. Grind the jaws to provide clearance if necessary.***

Generator Assembly

Assembly is the reverse of disassembly. The following procedures should be noted:

1. New field windings should be heated in an oven to about 300° F (150° C) before assembly between the frame and pole shoes. Heating softens the coils so that they can conform to the shape of the pole shoes and frame.

⚠CAUTION ***Unless the field windings are softened by heating, the pole shoes will not seat properly. Excessive torque will strip the pole shoe bolts.***

2. To install a new rotor shaft bearing, use a press and a short length of 1 inch pipe to apply pressure to the inner race of the bearing. Press the new bearing up to the scribe mark.

⚠CAUTION ***The bearing could be damaged if pressure is applied to the outer race.***

3. Lightly grease the bearing bore in the generator frame and line up the groove in the bearing race with the tang in the bore when installing the generator frame.

Rotor

These tests can be done without taking the generator apart, except for the armature short circuit test. Remove the brushes to isolate the armature during these tests.

Tests for ground: Use the R x 10K scale of an ohmmeter.

- Measure the resistance between any commutator bar and the rotor shaft and between any slip ring and the rotor shaft (Figures 8-3 and 8-4).
- A reading of less than one megohm indicates breakdown of the insulation for that winding. Replace the rotor if either reading is low.

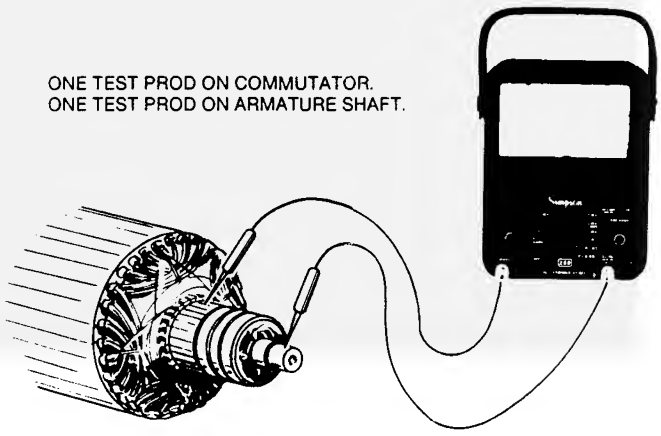


FIGURE 8-3. ARMATURE DC GROUND TEST

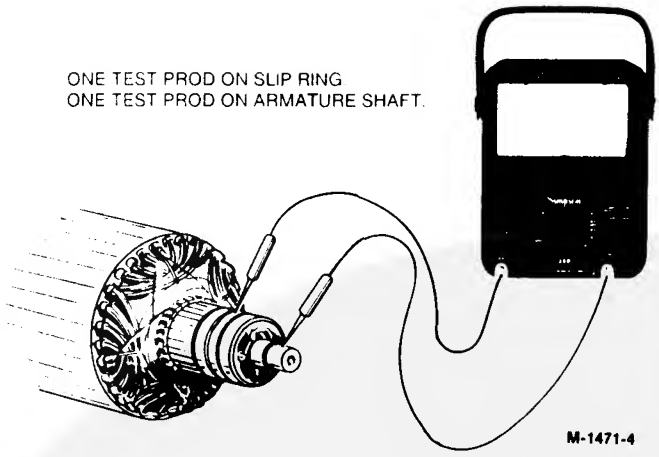


FIGURE 8-4. ARMATURE AC GROUND TEST

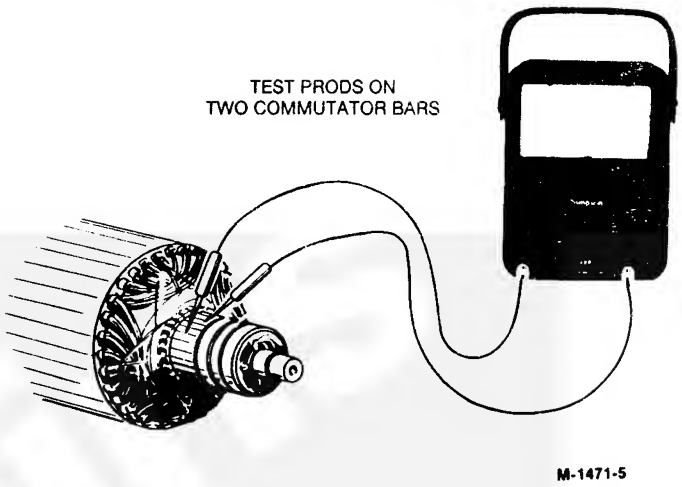


FIGURE 8-6. ARMATURE DC OPEN TEST

Tests for Open Windings: Use the R x 1 scale of the ohmmeter.

- Measure the resistance between the slip rings. If there are three slip rings, measure the resistance between the middle one and the one to each side of it, and between the two on each side (Figure 8-5).
- Measure the resistance between one of the commutator bars and each of the other bars in turn, all the way around (Figure 8-6).
- A high reading (off scale) indicates an open winding. Replace the rotor if any winding is open.

Tests for Short Circuits Between AC and DC Windings: Use the R x 10K scale of the ohmmeter. Measure the resistance between any commutator bar and any slip ring (Figure 8-7). A reading of less than one megohm indicates a breakdown of insulation between windings. Replace the rotor if the reading is low.

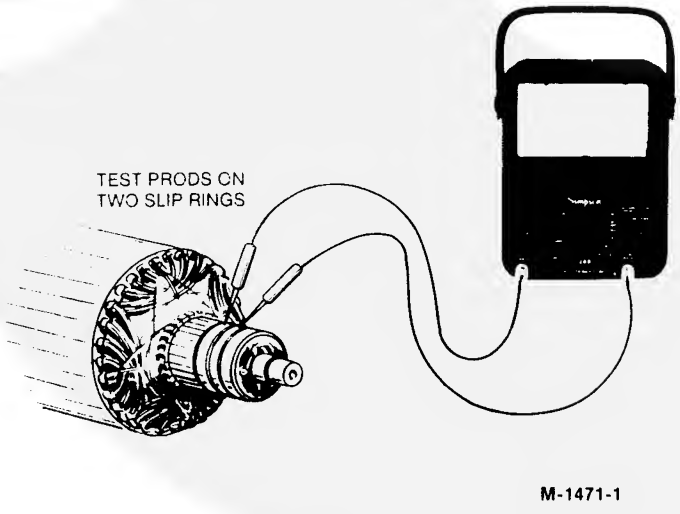


FIGURE 8-5. ARMATURE AC OPEN TEST

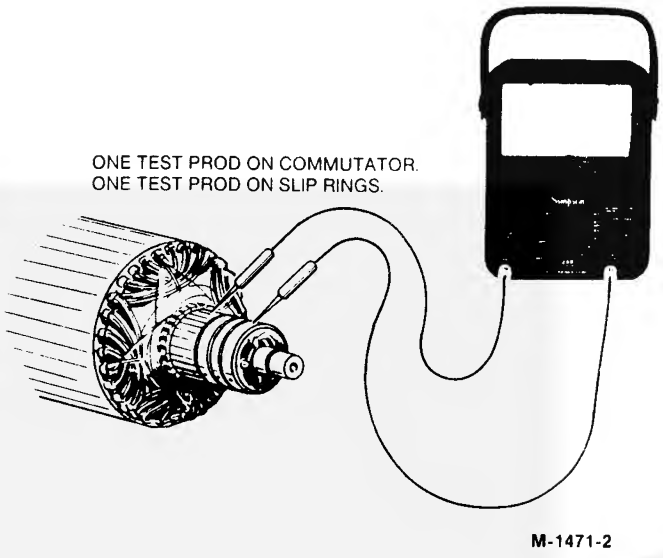


FIGURE 8-7. AC TO DC SHORT CIRCUIT TEST

Tests for Short Circuits: Place the armature in an armature growler (Figure 8-8). Turn on the growler and hold a steel blade parallel to and about 1/2 inch (12 mm) away from the laminated core of the armature. Move the blade around from one pole of the growler to the other. If the blade vibrates at any point, the winding is short circuited. Turn the growler off and rotate the armature one slot over and keep repeating the test until a complete revolution of the armature has been made. Replace a short circuited armature.

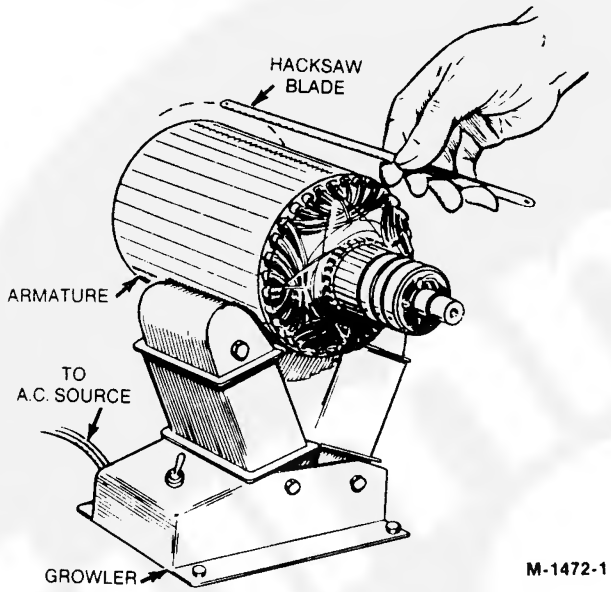


FIGURE 8-8. ARMATURE SHORT CIRCUIT TEST WITH GROWLER

Commutator and Slip Ring Service: If the commutator or slip rings are worn, grooved, pitted or out-of-round, re-finish by turning in a lathe. Remove as little metal as possible. Use number 240 sandpaper to remove tool marks or slight roughness that would not warrant turning. Do not use emery paper. Emery grit is conductive and can cause shorts.

If the commutator is worn, or has had to be turned in a lathe to the point that the mica insulation between the bars would touch the brushes, it will be necessary to undercut the mica (Figure 8-9). The figure shows a typical tool for this purpose.

⚠CAUTION ***Be careful not to damage the slip rings by accidentally drawing the mica cutting tool across the slip rings.***

Cut the mica down in each slot to approximately 1/32 inch (.8 mm) below the top of the bars. Carefully remove burrs in the commutator bars with number 240 sandpaper. Brush off all mica dust and metal particles.

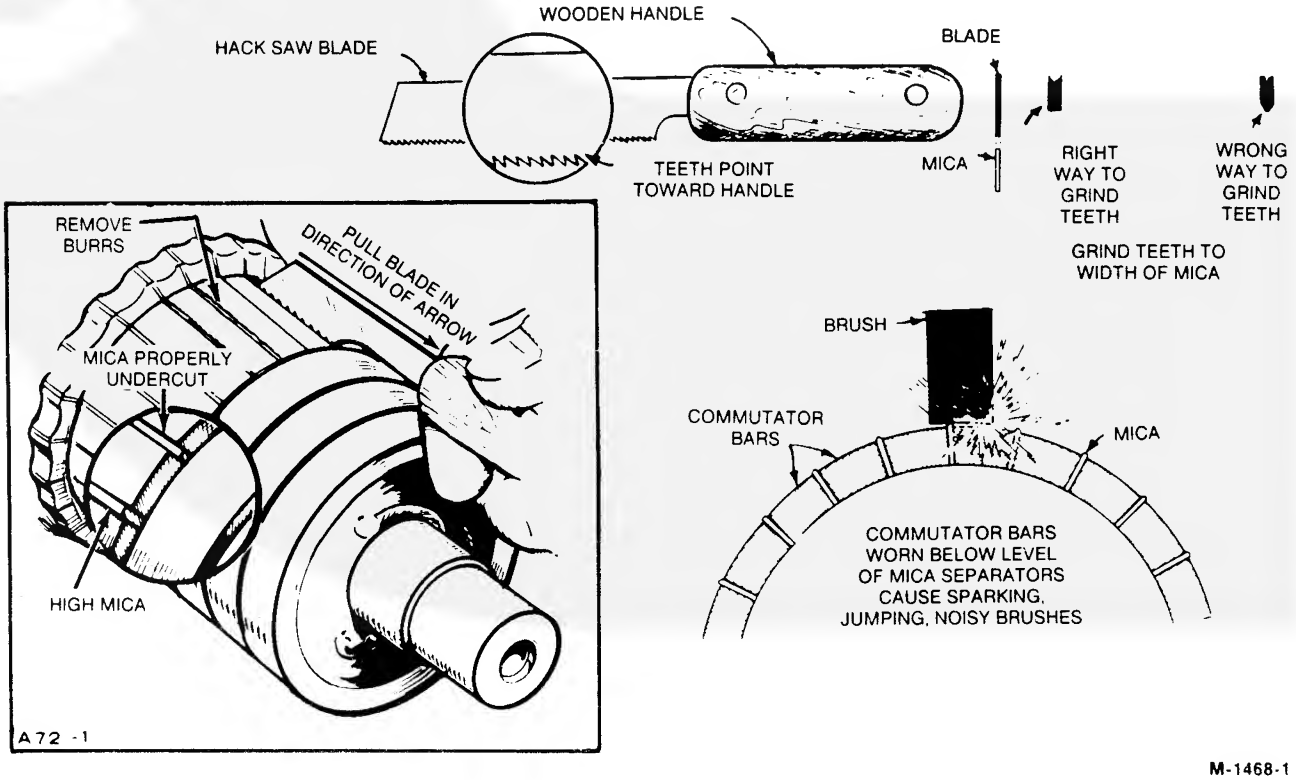


FIGURE 8-9. UNDERCUTTING MICA INSULATION

Field Windings

Tests for Open Windings: Use the R x 1 scale of the ohmmeter. This test can be done without taking the generator apart.

- On standard generators with electric start, isolate the field windings by disconnecting the leads from the terminals on the DC brush holders.
- On manual start generators, isolate the field windings by disconnecting the lead from the diode terminal on one side and the AC brush holder on the other side.
- On RV generators, isolate the windings by removing the DC brushes.
- On manual start generators, measure the resistance between the two leads.
- On electric start and RV generators measure the resistance between terminal S-1 on the starter solenoid and each of the other two leads.
- A high reading (off scale) indicates an open winding . Replace an open winding.

Tests for Grounded Windings: Use the R x 10K scale of the ohmmeter.

- On standard manual or electric start generators, measure the resistance between each lead and the frame of the generator, including the lead connected to terminal S1 of the starter solenoid. A reading of less than one megohm indicates insulation breakdown. Replace the windings if the reading is low.
- On RV generators, the generator frame has to be removed from the engine to perform this test. With the generator frame removed from the engine, disconnect the field winding lead connected at the grounding terminal between the field pole shoes. Measure the resistance between each lead and the generator frame, including the lead connected to terminal S-1 of the starter solenoid. A reading of less than one megohm indicates insulation breakdown. Replace the windings if the reading is low.

Brushes

Replace the brushes if they are worn to a length of less than 5/8 inches (18 mm) or are grooved. Replacement brushes are shaped to fit the curvature of the commutator or slip ring. If sparking does occur, run the set under light loads until the brushes wear in. Work the brushes up and down in the brush holder to make sure there is no sticking or binding. Clean out the brush holder with a bristle brush if there is sticking or binding.

Diodes

Use the R x 1 scale of the ohmmeter to test the diodes on manual start generator sets (Figure 8-10). Disconnect the field lead from the diode terminal and the diode lead from the brush terminal to isolate the two diodes for the test. Measure the resistance across each diode in each direction by switching the test probes from one side to the other. If the diodes are working properly, the resistance in one direction will be much less than in the other. If there is a high resistance in both directions or a low resistance in both directions, replace the diode. Make sure the brass jumper strip between diode terminals is reassembled if the diodes are removed.

Capacitors

On standard AC generator sets, a capacitor is connected between each ungrounded brush assembly and ground to reduce "noise" in the electrical output. Test for shorted capacitors with an ohmmeter, using the R x 10K scale. Isolate the capacitor for testing by disconnecting the lead from the brush terminal (Figure 8-10). Replace a capacitor with a low resistance reading or if there is "noise" in the electrical output.

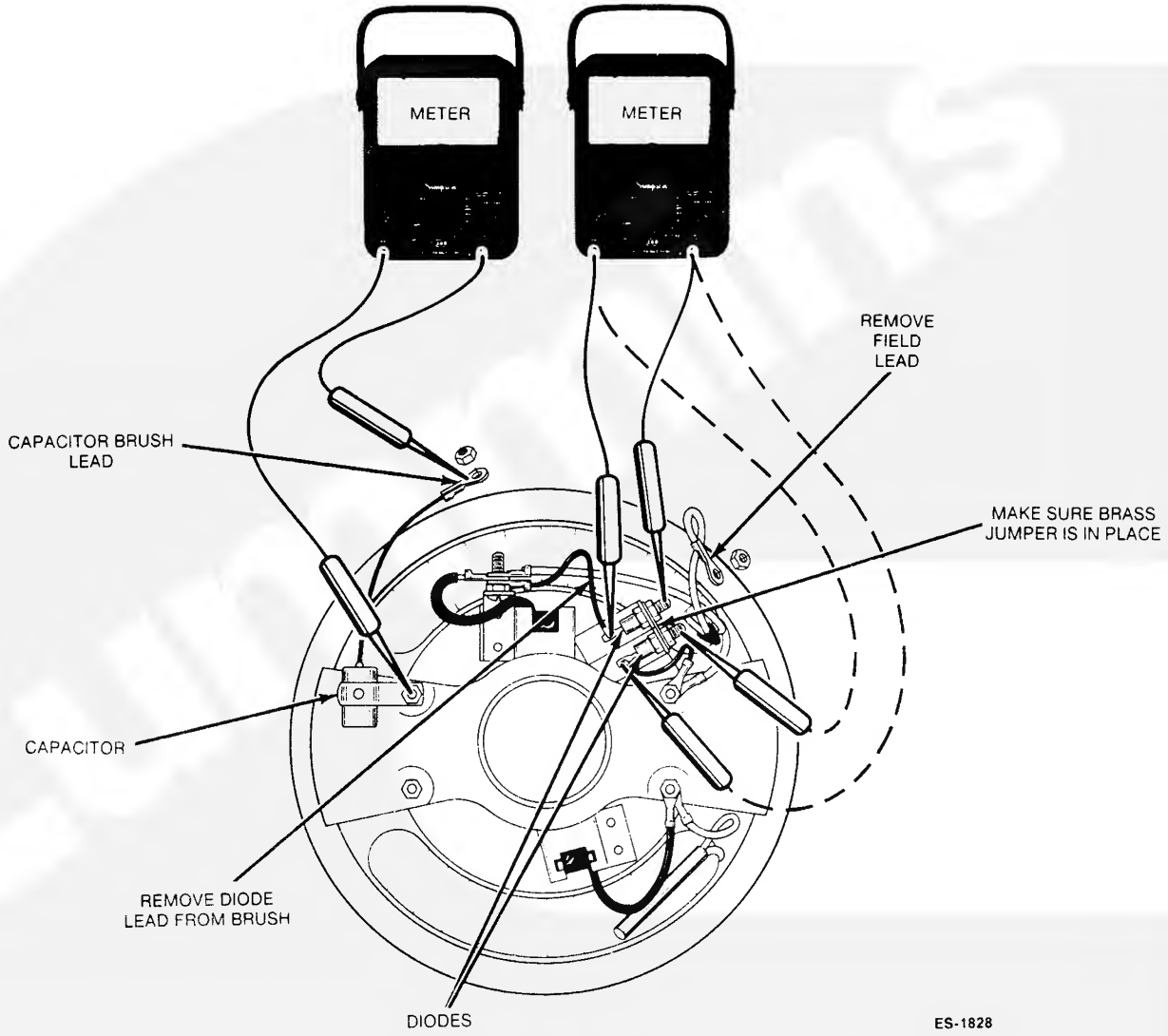


FIGURE 8-10. TESTING DIODES AND CAPACITORS

Section 9. Engine - Block Assembly

INTRODUCTION

The engine block assembly includes the cylinder block, cylinder head, piston and connecting rod assembly, crankshaft, camshaft, valves, valve springs and tappets, lubrication system, timing gears, governor mechanism and bearings.

In order to perform most of the procedures in this section it will be necessary to remove the set from the installation and to remove the generator and the engine primary systems from the block assembly. Refer to the previous sections.

CYLINDER HEAD

Remove the cylinder head for cleaning when poor engine performance is noticed. Proceed as follows:

1. Use a socket wrench to remove the cylinder head bolts and then lift off the head.

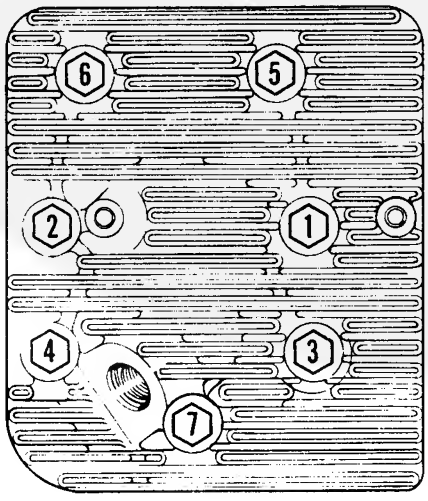
   ⚠CAUTION ***The head may warp if it is removed when the engine is hot. Let the engine cool before removing the head.***

2. After removing the head, clean all carbon deposits from the head, piston and cylinder. Be careful not to gouge the surfaces that seal against the gasket.

3. Install a new head gasket.

4. Place the head in position and follow the tightening sequence shown in Figure 9-1. Tighten all head bolts to 5 ft-lbs (7 N•m), then to 10 ft-lbs (14 N•m), etc., until they are tightened to 24 -26 ft-lbs (33 to 35 N•m).

5. Torque the head bolts again after the set has run 25 hours.

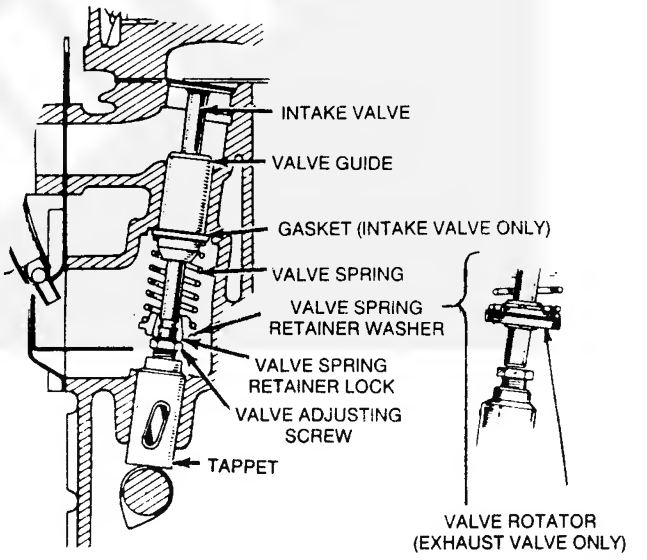


M-1791

FIGURE 9-1. CYLINDER HEAD TORQUE SEQUENCE

VALVE SYSTEM

The valve system must work properly if the engine is to perform as expected. Remove the cylinder head and valve cover for access to the valves, valve springs, valve guides and tappets. A valve spring compressor must be used to remove valves from the cylinder block.



VT-1047

FIGURE 9-2. VALVE SYSTEM

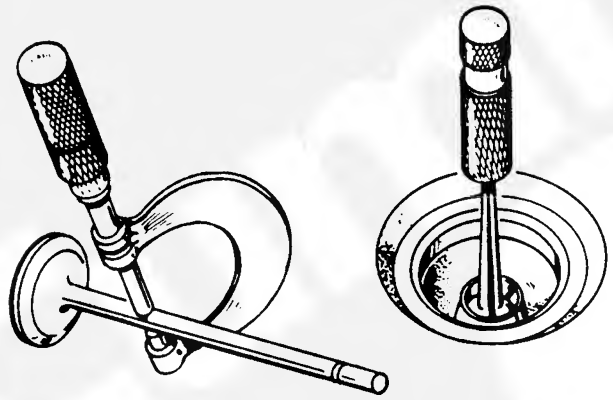
Inspection

Valve Face: Check the valve face for burning, pitting, warpage, and carbon deposits.

Burning and pitting occur when the valve does not seat tightly. This is often the result of hard carbon deposits on the seat. It may also be due to weak valve springs, insufficient tappet (lifter) clearance, warpage, and misalignment. Warpage occurs chiefly in the upper stem due to exposure to intense heat. Misalignment of the valve and valve seat could be the result of not having ground the valve seat concentric with the valve guide. If a valve face is burned or warped, or the stem worn, install a new valve and grind the valve seat.

Stems and Guides: Check valve stems and guides for wear as shown in Figure 9-3. Use a hole gauge to measure the valve guide bore. When clearance exceeds the specified limits, replace either the valve, the guide, or both, as necessary. Always regrind the seat to make it concentric with the newly installed guide.

Too much clearance between the intake valve and its guide allows air and oil to be drawn into the cylinder, upsetting carburetion, increasing oil consumption and causing heavy carbon deposits. Carbon deposits reduce heat flow, resulting in higher combustion temperatures that could cause valves to warp. Deposits of hard carbon with sharp points become white hot and can cause pre-ignition. Unburned carbon residue gums valve stems and can cause them to stick in their guides.



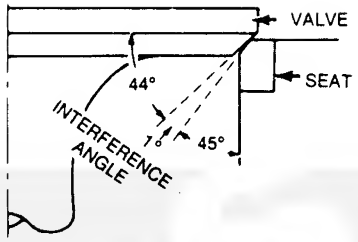
VT-1020

FIGURE 9-3. VALVE STEM & VALVE GUIDE INSPECTION

Springs: Check the valve springs for cracks, worn ends, straightness and tension. If spring ends are worn, check the valve spring retainer for wear. Check spring height and straightness by placing the spring on a flat surface next to a square and rotating it against the square. Check spring tension at the open valve height using an accurate valve spring tester. Replace any valve spring that is weak, cracked, worn or bent.

Reconditioning Valves and Valve Seats

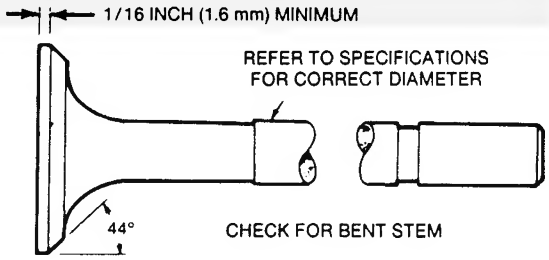
The valve face angle is 44 degrees. The valve seat angle is 45 degrees. The difference in angle results in a sharp seat between the valve and valve seat (Figure 9-4). Hand lapping is not recommended since it breaks down the sharp seat.



VT-1021

FIGURE 9-4. VALVE INTERFERENCE ANGLE

A valve must have a minimum of 1/16-inch (1.6 mm) margin (Figure 9-5). Replace a valve with less margin since it will heat up excessively. As a result, the valve could warp or burn and start leaking or the edge could get hot enough to cause pre-ignition.



VT-1022

FIGURE 9-5. VALVE MARGIN

Not all valves can be reconditioned. A badly warped or deeply pitted valve must be replaced because the excessive grinding required to make it seat correctly removes the margin. To make a valve gas-tight, every trace of pitting must be removed from the valve face and seat.

Valve seats should be ground with a 45-degree stone. The seat band should be 1/32 to 3/64 inch (0.79 to 1.2 mm) wide. Grind only enough to ensure proper seating. Narrow the seat width if necessary with a 30 or 60-degree stone.

Check each valve for a tight seat. Make several marks at regular intervals across the valve face using machinist's blueing. Insert the valve and rotate it one quarter turn against the seat. The valve seat should contact the valve face evenly at all points as indicated by the blueing that rubs off. The line of contact should be at the center of the valve face.

Valve Guide Replacement

Worn valve stem guides are accessible by removing the valve cover. The tappets are also accessible after the valve assembly has been removed.

Removal: Before removing the valve guides, use an electric drill with a wire brush to remove carbon and other foreign material from the top surface of the guides. Failure to perform this operation may result in damage to the guide bores. Drive the guides out with a hammer and valve guide driver.

⚠CAUTION ***Driving out old guides can damage the tappet bores. Be careful not to strike the bores with the driver.***

Installation: Run a small polishing rod with crocus cloth through the valve guide bores to clean out carbon and other foreign materials. Place a new gasket on the intake valve guide and coat the outer edge of each new guide with oil. Insert the new guides and pull them up until the shoulders bottom. A suggested method is shown in Figure 9-6.

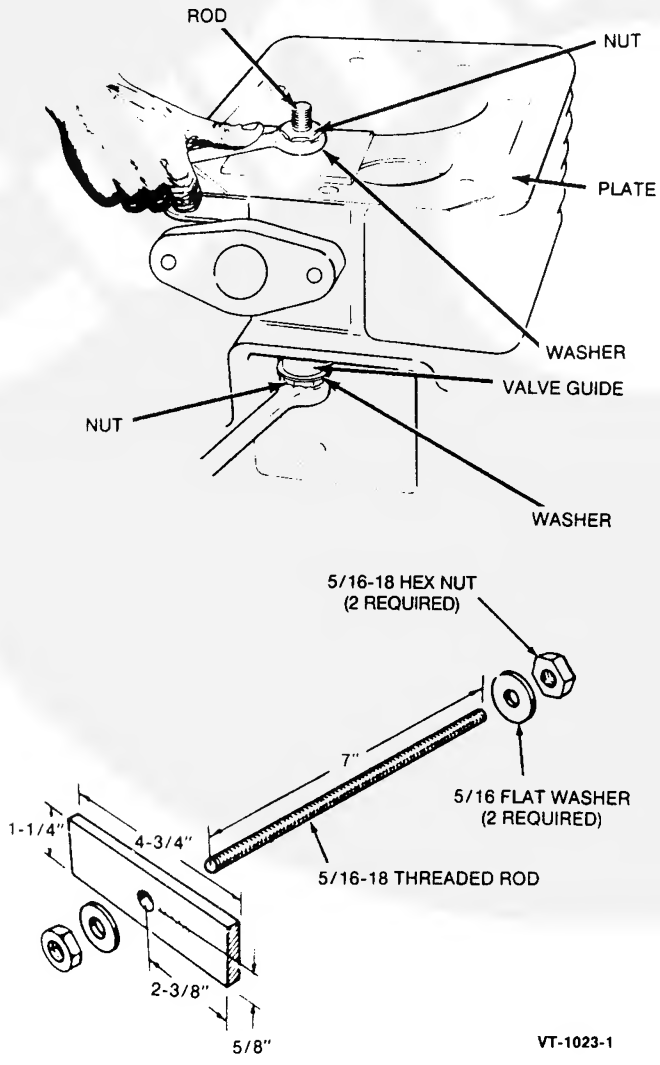


FIGURE 9-6. VALVE GUIDE INSTALLATION

Valve Seat Inserts

Remove the valve seat insert if it is loose, cracked or pitted beyond repair.

Replacement: After the old seat has been removed, clean out any carbon or metal burrs from the seat insert bore. If the seat bore has been damaged by extracting the old seat, use a valve seat cutting tool to bore to the next oversize.

Use a valve seat insert driver and a hammer to install the insert. Insert the pilot of the tool into the valve guide. Drive the valve seat insert evenly to the bottom of the recess in the cylinder block. Make certain that the valve seat insert rests solidly on the bottom of the recess all the way around its circumference (Figure 9-7). Installation is easier if the the insert is cooled in dry ice for one-half hour.

⚠CAUTION ***Dry ice can injure the skin. Handle with gloves.***

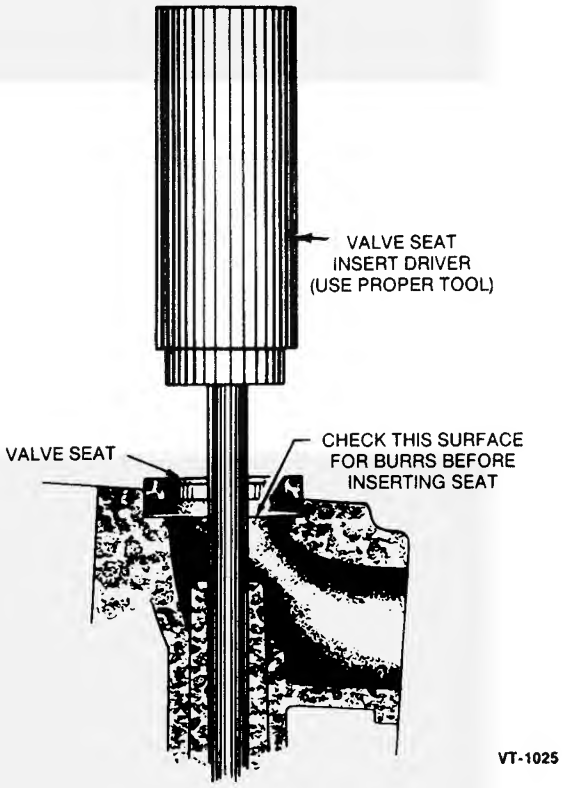


FIGURE 9-7. INSERTING NEW VALVE SEAT

Tappet Adjustment

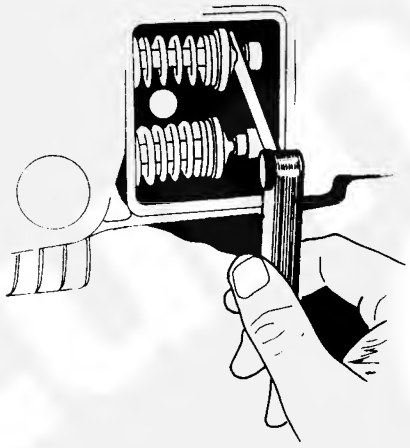
The engine is equipped with adjustable valve tappets. Adjust the valve clearance only when the engine is at ambient temperature. Proceed as follows:

1. Remove all parts necessary to gain access to the valve tappets.
2. Remove the spark plug to make turning the engine easier.

3. Place a socket wrench on the flywheel capscrew and rotate the crankshaft in a clockwise direction until the intake valve (the one nearest the carburetor) opens and closes. Continue turning the crankshaft until the mark on the flywheel is lined up with the TC mark on the gear cover. Alternatively, for RV models, if the fan and housing are still in place, the TC mark on the fan is visible through a peep hole in the fan housing when the piston is at TC. Verify that the intake and exhaust valves are closed. There should be clearance between the valve and tappet.

4. Measure the valve clearance as shown in Figure 9-8. Clearance specifications are listed in Section 3.

5. To adjust the valve clearance, turn the adjusting screw as needed to obtain the specified clearance. The screw is self-locking.



VT-1026-1

FIGURE 9-8. MEASURING VALVE CLEARANCE

GEAR COVER

Remove the flywheel, flywheel key and cover mounting screws. Tap the gear cover gently, using a soft-faced hammer to loosen it.

When removing the gear cover, it is not necessary to remove the magneto assembly from the cover. Just disconnect the spark plug lead at the spark plug. When installing the gear cover, make sure the pin in the gear cover engages the hole in the governor cup that has the nylon bushing (Figure 9-9). Turn the governor cup so that the hole is in an upward (12 o'clock) position. Turn the governor arm and shaft clockwise as far as possible and hold in this position until the gear cover is installed flush against the crankcase. Be careful not to damage the gear cover oil seal. Keep the oil seal driver on to keep the seal expanded while the crankshaft slips through. Refer to Oil Seals below for details about oil seal installation.

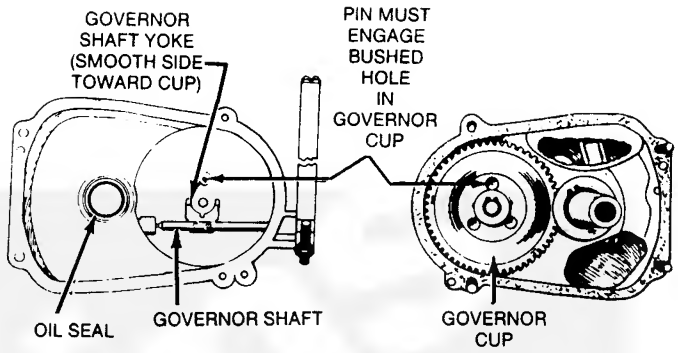


FIGURE 9-9. GEAR COVER ASSEMBLY

GOVERNOR CUP

With the gear cover removed, the governor cup can be taken off after removing the snap ring from the camshaft center pin. Catch the flyballs while sliding the cup off.

Replace any flyball that is grooved or has a flat spot. If the arms of the ball spacer are worn or otherwise damaged, replace the whole gear/spacer assembly. The governor cup must spin freely on the camshaft center pin without excessive looseness or wobble. If the race surface of the cup is grooved or rough, replace it with a new one.

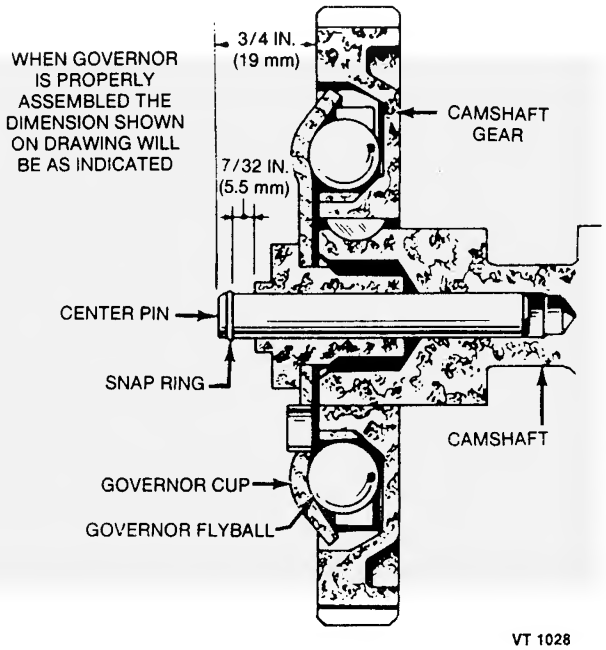


FIGURE 9-10. GOVERNOR CUP

If a new governor cup is being installed, the distance from the small lock ring on the center pin to the face of the governor cup must be exactly 7/32 inch (5.5 mm) when the cup is pressed back against the flyballs as far as possible. If the distance is too small, carefully dress the face of the cup as required, being sure to remove any burr from the inside of the cup bore. If the distance is more than 7/32 inch (5.5 mm), carefully press the pin in the required amount. Do not damage the pin. It is difficult to replace it in the field. Replacement of governor flyballs is easier if the set is tipped backward with the timing gears upward. Be sure that all flyballs are replaced and evenly spaced.

TIMING GEARS AND CAMSHAFT

If replacement of either the crankshaft gear or the camshaft gear becomes necessary, both gears should be replaced.

To remove the crankshaft gear, remove the snap ring and retainer washer and then attach a gear pulling ring (Figure 9-11). Tighten the screws alternately until both are tight. Attach a gear puller to the pulling ring and remove the gear.

The camshaft and gear are removed as an assembly. Before removing the camshaft and gear assembly, remove the valve tappets, fuel pump and ignition or flicker point assembly and operating plunger.

To reinstall the crankshaft gear, heat it in an oven to 325°F (168°C). Make sure the key is in place, and tap the gear down to the shoulder on the crankshaft. Attach the retaining washer and snap ring.

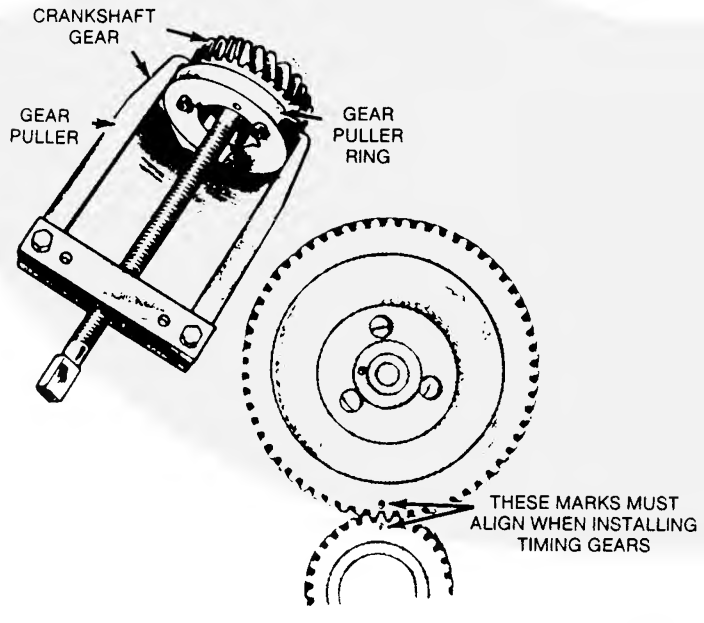


FIGURE 9-11. TIMING GEAR REMOVAL AND INSTALLATION

Each timing gear is stamped with "O" near the edge. The gear teeth must mesh so that these marks exactly coincide when the gears are installed in the engine. When installing the camshaft gear and shaft assembly, be sure that the thrust washer is properly in place behind the camshaft gear. Then install the crankshaft gear retaining washer and lock ring.

LUBRICATION SYSTEM

Allow engine to cool before draining oil. Drain the oil before removing the oil base and always use a new gasket when replacing the oil base.

An oil pump provides a constant flow of oil to the engine parts. The oil supply collects in the oil base where it is picked up by the oil pump pick-up cup. A by-pass valve is used to control oil pressure.

The oil pump is mounted on the front of the crankcase behind the gear cover and is driven by the crankshaft gear. The inlet pipe and screen assembly is attached directly to the pump body. A discharge passage in the cover of the pump registers with a drilled passage in the crankcase that leads to the front main bearing. A circumferential groove in the main bearing allows oil to cross over to a drilled passage that leads to the front camshaft bearing. The connecting rod journal is lubricated through a drilled passage from the main journal. A copper crossover tube carries oil to the rear main bearing. The oil overflow from the bypass valve lubricates the camshaft drive gears (Figure 9-12).

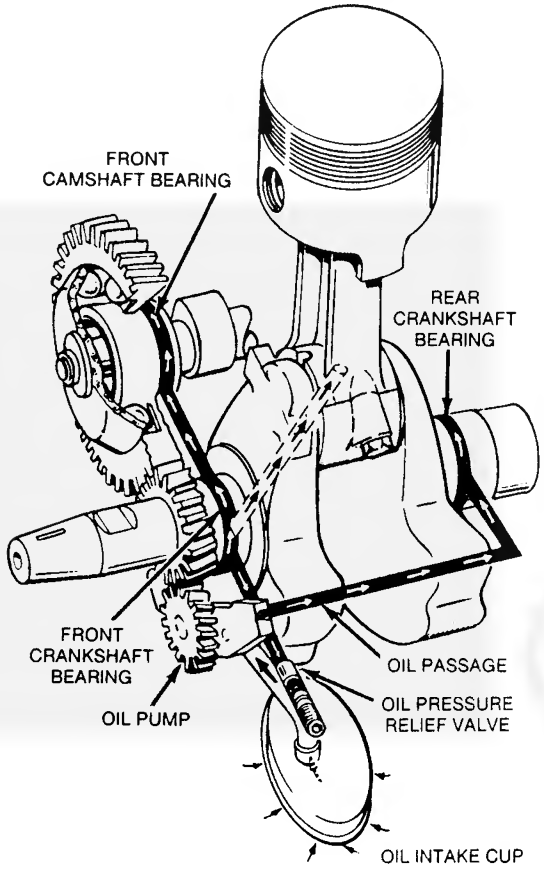


FIGURE 9-12. OIL SYSTEM

Normal oil pressure is 30 psi (207 kPa) or higher when the engine is at normal operating temperature. If pressure drops below this value at governed speed, inspect the oil system for faulty components. If the engine is equipped with a low oil pressure cutoff switch, the pressure can be measured with a pressure gauge connected at the tapping for the pressure switch.

Oil Pump

Check the oil pump thoroughly for worn parts. Oil the pump to prime it before reinstalling. Except for the gaskets and pick-up cup, individual components of the pump are not available. Install a new pump assembly if any parts are worn.

Oil By-pass Valve

The oil by-pass valve controls oil pressure by allowing excess oil to drain back to the crankcase. The valve (Figure 9-13) is non-adjustable and normally needs no maintenance. If oil pressure is abnormally low or high inspect the valve as follows:

1. Remove the plug located on the right side of the engine block (as you face the gear cover).

2. Remove the ball, spring and plunger with a magnetic tool.

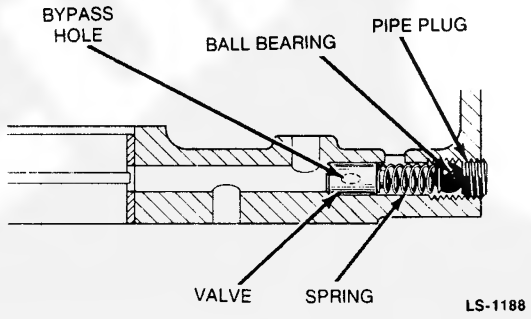


FIGURE 9-13. OIL BYPASS VALVE

3. Check the following dimensions:
   Plunger Diameter ..... 0.3105 to 0.3125 in. (7.89 to 7.94 mm)
   Spring Free Length ..... 1 in. (25.4 mm)
   Spring Load .....2.4 to 2.8 lbs (1.1 to 1.2 kg) when compressed to 1/2 in. (12.7 mm)

4. Check the valve seat and clean away any accumulation of metal particles that could cause erratic valve action. Verify that the valve seat is concentric with the larger diameter valve bore.

5. Clean the plunger, ball and spring in parts-cleaning solvent and reinstall.

Valve Compartment Oil Drain

A drain hole from the valve compartment allows oil to enter the crankcase. This hole must be unobstructed to provide for proper drainage of oil from the valve compartment.

CYLINDER BLOCK

The cylinder block is the main support for all other basic engine parts. After removing the piston assembly, crankshaft, camshaft, oil pump, etc., clean the block and look for cracks and wear.

Cleaning

1. Scrape all old gasket material from the block. Remove the oil bypass assembly to allow cleaning solution to contact the inside of the oil passages.

2. Remove grease and scale from the cylinder block by agitating in a bath of commercial cleaning solution or hot soapy water. Be sure to follow manufacturer's instructions and warnings when using cleaning solution.

3. Rinse the block in clean hot water to remove the cleaning solution.

General Inspection

After thorough cleaning and drying inspect the block for any condition that would make it unfit for further use.

1. Make a thorough check for cracks. Minute cracks can be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light motor oil. Wipe the part dry and immediately apply a coating of zinc oxide (white lead) dissolved in wood alcohol. If cracks are present, the white coating will become discolored at the defective area. Always replace a cracked cylinder block.

2. Inspect all machined surfaces and threaded holes. Carefully remove any nicks or burrs from machined surfaces. Clean out tapped holes and clean up any damaged threads.

3. Check the top of the block for flatness with a straight edge and a feeler gauge.

Cylinder Bore Inspection

Inspect the cylinder bore for scuffing, scratches, wear, and scoring. If the cylinder bore is scuffed, scratched, scored, or worn, it must be machined for the next oversize piston.

When the appearance of the cylinder bore is good and there are no scuff marks, check the cylinder bore for wear or out-of-roundness as follows:

1. Check the cylinder bore for taper, out-of-roundness and wear with a cylinder bore gauge, telescope gauge, or inside micrometer. Take four measurements: two at the top of ring travel, parallel and perpendicular to the crank, and two at the bottom of ring travel, parallel and perpendicular to the crank.

2. Record measurements taken at the top and bottom of piston travel as follows (Figure 9-14).

   A. Measure and record as "A" the cylinder bore diameter parallel to the crankshaft near the top of the cylinder bore where the greatest amount of wear occurs.

   B. Measure and record as "B" the cylinder bore diameter parallel to the crankshaft at the bottom of piston travel.

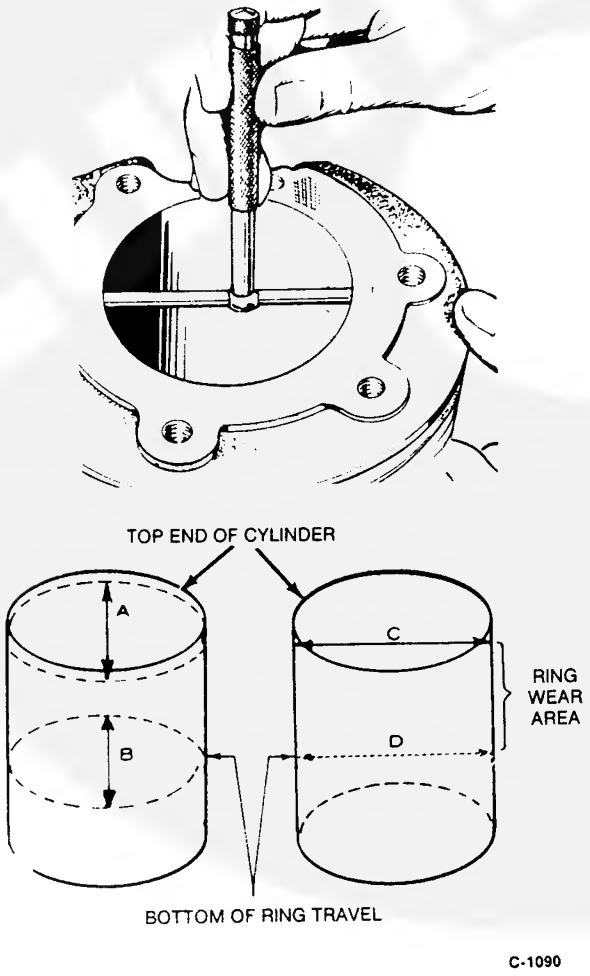


FIGURE 9-14. METHODS OF MEASURING THE DIAMETER OF A CYLINDER BORE

   C. Measure and record as "C" the cylinder bore diameter perpendicular to the crankshaft near the top of the cylinder bore where the greatest amount of wear occurs.

   D. Measure and record as "D" the cylinder bore diameter perpendicular to the crankshaft at the bottom of piston travel.

   E. Reading "A" subtracted from reading "B" and reading "C" subtracted from reading "D" indicate cylinder taper. If taper exceeds 0.005 inch (0.13 mm), machine the cylinder to accommodate the next oversize piston.

   F. Reading "A" compared to reading "C" and reading "B" compared to reading "D" indicate whether or not cylinder is out-of-round. If out-of-roundness exceeds 0.003 inch (0.08 mm), the cylinders must be machined to the next oversize.

Machining the Cylinder Bore

Oversize pistons and rings will fit with the required clearance in cylinders machined to the matching oversize. There is no need to adjust or "fit" pistons and rings. Pistons and rings should be measured as described below to confirm the correct sizes. Boring and/or honing must be accurate and remove just enough metal for the smallest oversize possible. The finish hone should leave a fine crosshatch pattern with an angle of approximately 23 degrees (Figure 9-15). The crosshatch helps to break-in the piston rings quickly.

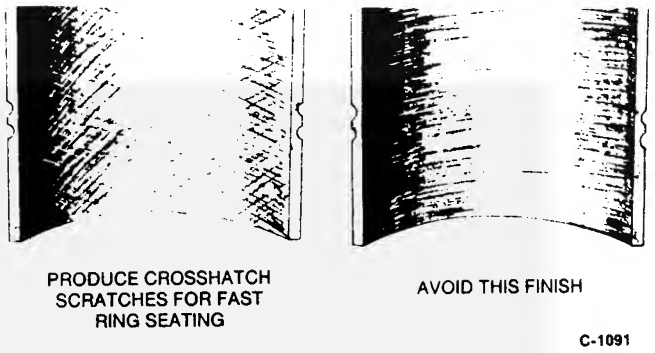


FIGURE 9-15. CROSSHATCHING

Clean the cylinder after machining with hot, soapy water and clean rags. A clean white rag will not soil when the cylinder walls are clean. Dry the cylinder and coat it with oil.

⚠CAUTION ***Never use gasoline or commercial cleaners to clean the cylinder bore after deglazing or honing. These solvents will not remove abrasives from the walls. Abrasives not removed from the cylinder will rapidly wear rings, cylinder walls, and bearings.***

Deglazing the Cylinder Bore

Deglaze the cylinder bore before installing new rings if there are no scuff marks and no wear or out-of-roundness that would warrant machining. Deglazing provides the crosshatch pattern for fast ring break-in without increasing the cylinder diameter. The original piston with new rings can then be used. Proceed as follows:

1. Wipe the cylinder bore with a clean cloth that has been dipped in clean, light engine oil.

2. Use a brush type deglazing tool with coated bristle tips to produce a crosshatch pattern in the cylinder bore.

3. The deglazing tool should be driven by a slow-speed drill. Move the deglazing tool up and down in the cylinder rapidly enough to obtain a crosshatch pattern as shown in Figure 9-15. Ten to twelve complete strokes should be sufficient.

4. Clean the cylinder after deglazing with hot, soapy water and clean rags. A clean white rag will not soil when the cylinder walls are clean. Dry the cylinder and coat it with oil.

BEARINGS

Removal of the camshaft or crankshaft bearings requires complete disassembly of the engine. Use a press or a suitable plug to remove the bearings. Support the casting to avoid distorting or damaging the bearing bore during removal and installation. Remove the expansion plug for access to the rear camshaft bearing. Use oil on the bearings to reduce friction when installing, and lubricate again with oil after installation. A combination bearing driver is available for installing the crankshaft and camshaft bearings.

Camshaft Bearings

Coat the bearing with lubricating oil. Position the front bearing with the lubricating groove at the top (Figure 9-16). Be sure to start the bearing straight. Press the front bearing in flush with the edge of the bore. Press the rear bearing in flush with the counterbore (Figure 9-16). Pound a new expansion plug into the counterbore. Use Permatex around the edge of the plug.

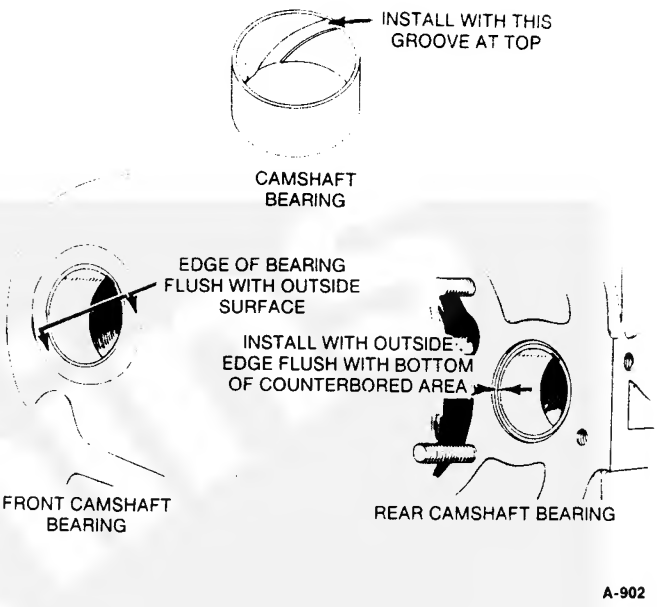


FIGURE 9-16. CAMSHAFT BEARINGS

Crankshaft Bearings

When putting in either the front or rear main bearing, align the oil hole(s) in the bearing bore (Figure 9-17). The oil passage must be at least half open. The bearing should require only light taps to position it. Install the bearing flush with the edge of the bore. For easier installation, it is recommended that the bearings be cooled with dry ice for half an hour.

⚠CAUTION ***Dry ice can injure the skin. Handle with dry gloves.***

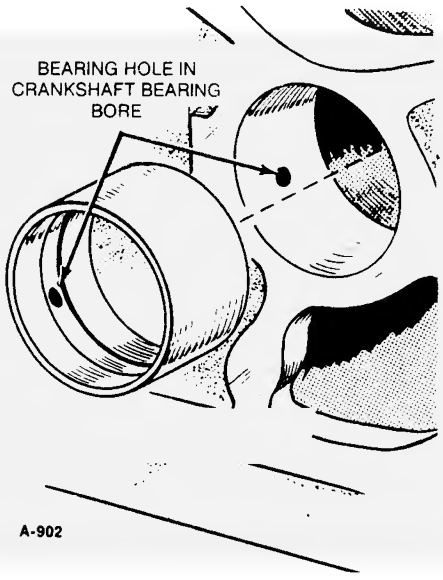


FIGURE 9-17. CRANKSHAFT BEARINGS

OIL SEALS

The rear bearing plate and gear cover must be removed to replace their respective oil seals. Use an oil seal puller to pull out the old seals. New oil seals should be installed with oil seal drivers. The drivers include a guide that expands the seal to protect it while the end of the crankshaft goes through.

Before installing, lubricate the seal lip with oil or grease. Drive the seals in to the edges of their bores (Figure 9-18).

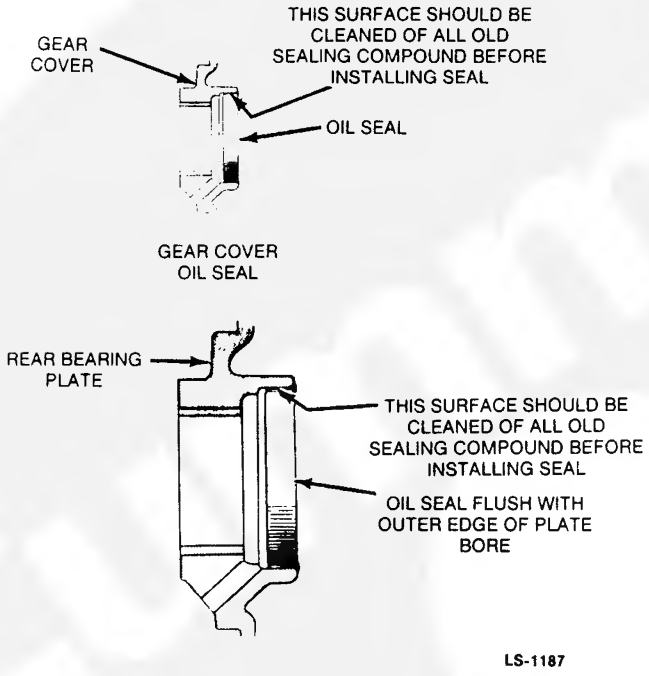


FIGURE 9-18. OIL SEALS

CRANKSHAFT

Clean the crankshaft thoroughly and inspect the journals for scoring, chipping, cracking or signs of overheating. Measure the main and connecting rod journals at several places on each journal to check for out-of-roundness and taper.

The crankshaft must be replaced if it cannot be reconditioned by regrinding the journals. Undersize main bearings and piston rods with undersize bores are available in several sizes. See Dimensions and Clearances. Metalizing journals is not recommended.

Inspect and clean out the drilled oil passage in the crankshaft to ensure lubrication of the connecting rod journal.

Oil the front main bearing and the crankshaft journal and carefully install the crankshaft through the rear opening in the block. Assembly will be easier if the block is turned so that the axis of the crankshaft is vertical. Align the rear bearing plate with the rear crankshaft journal and carefully push it on so that it lines up with the mounting bolts. The rear oil seal should have been installed in the rear bearing plate before it is installed. Keep the seal guide in place to protect the seal while the crankshaft is being inserted. Refer to Oil Seals above for details.

After the rear bearing end plate bolts have been torqued as specified in Torque Specifications, check the crankshaft endplay as shown in Figure 9-19. See Dimensions and Clearances for the specified endplay. If there is too much endplay, remove the rear bearing end plate and replace the gasket with a thinner gasket from the gasket kit. For too little endplay, remove the rear bearing end plate and replace the gasket with a thicker one. Torque the bolts and recheck the endplay of the crankshaft.

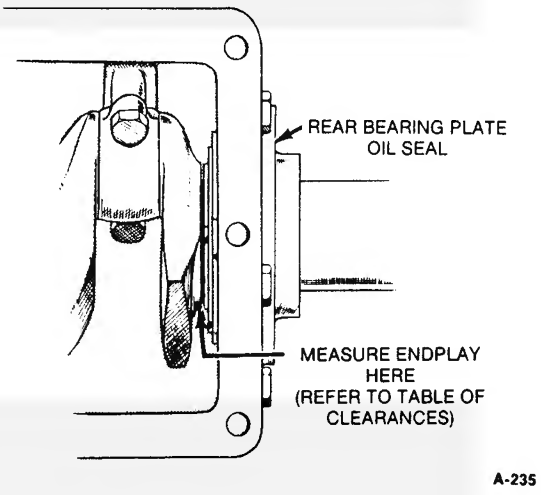


FIGURE 9-19. MEASURING CRANKSHAFT ENDPLAY

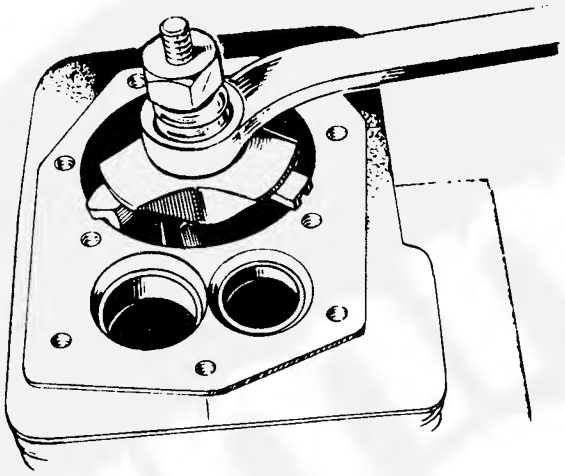
PISTON ASSEMBLY

The piston assembly consists of the piston, piston rings, piston pin and connecting rod . After removal from the engine, all parts must be carefully cleaned and inspected for damage and wear.

Removal and Disassembly

Remove carbon from the top of the cylinder bore and check for a ridge. Remove the ridge (Figure 9-20) with a ridge reamer before removing the piston.

⚠CAUTION ***Be careful not to gouge the cylinder wall with the ridge reamer.***



CT-1058

FIGURE 9-20. REMOVING THE WEAR RIDGE

To remove the piston and connecting rod assembly, turn the crankshaft until the piston is at the bottom of the stroke. Remove the cap of the connecting rod and push the rod and piston out the top of the cylinder with the wood handle of a hammer.

⚠CAUTION ***Forcing the piston from the cylinder before reaming the ridge can damage the piston lands and break the rings.***

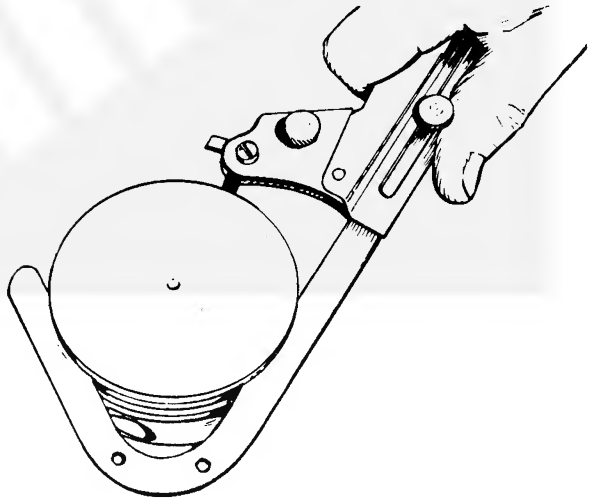
Remove the piston pin retainer from each side and push the pin out.

The piston is fitted with two compression rings and one oil control ring. Remove these rings from the piston using a piston ring spreader.

Clean the piston ring grooves with a groove cleaner or the end of a broken ring filed to a sharp point (Figure 9-21). Thoroughly clean the piston and rod with hot soapy water or other non-corrosive solvent.

⚠CAUTION ***Most commercial engine cleaning solvents are corrosive to aluminum. Check compatibility before using to clean pistons and connecting rods.***

Wire brushing removes metal from aluminum pistons and rods. Use natural or plastic fiber brushes for cleaning.



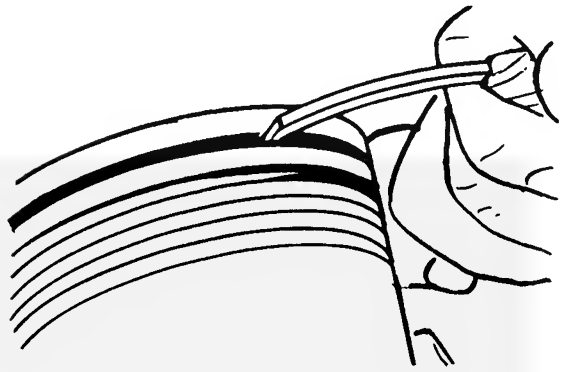


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FIGURE 9-21. CLEANING RING GROOVES

Piston Inspection

Inspect the piston for fractures at the ring lands, skirts and pin bosses. Check for wear at the ring lands using a new ring and feeler gauge as shown in Figure 9-22. Replace the piston if the side clearance of the top compression ring exceeds 0.006 inch (0.15mm).

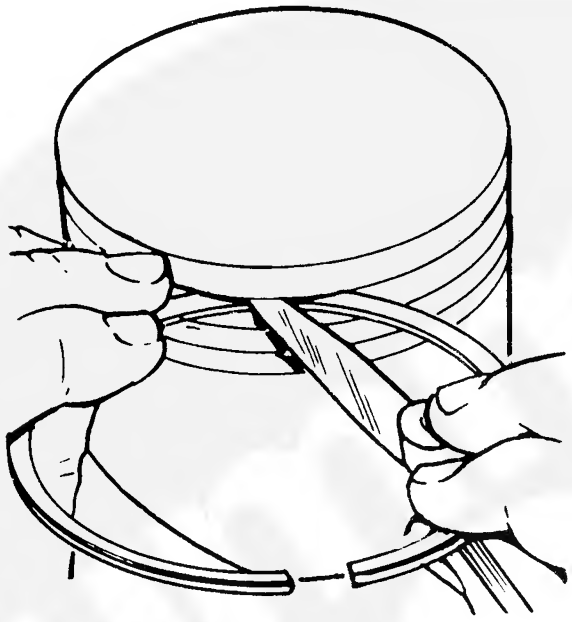

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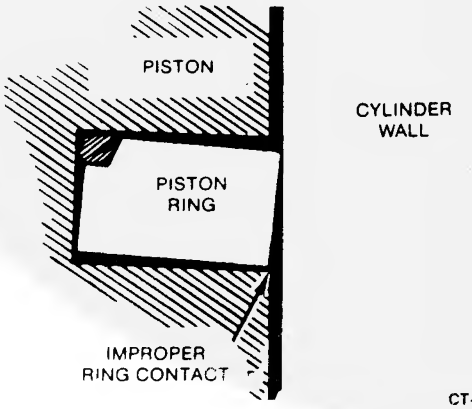
FIGURE 9-22. CHECKING RING LAND

Improper ring width or excessive ring side clearance can result in ring breakage. New rings in worn ring grooves have poor cylinder wall contact (Figure 9-23).



CT-1062

FIGURE 9-23. NEW RING IN WORN RING GROOVE

Replace the piston if it shows signs of scuffing, scoring, worn ring lands, fractures or damage from pre-ignition. Pistons and piston rings are available in standard size and oversizes. (See Dimensions and Clearances.)

Rod Inspection

Replace connecting rod bolts that have damaged threads. Replace the connecting rod if it has deep nicks, stripped threads, signs of fractures, a scored bore, or a bore out-of-round more than 0.002 inch (0.05mm). Connecting rods are available with standard and undersize bores. (See Dimensions and Clearances.)

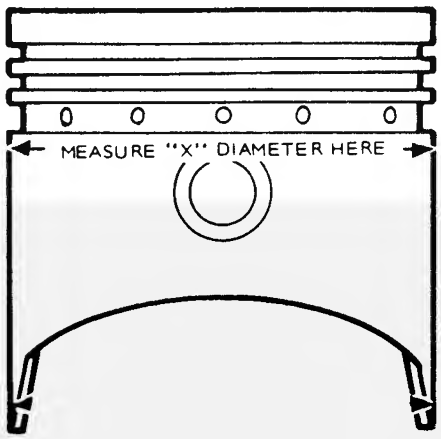
Use a new piston pin to check the connecting rod for wear. A push-fit clearance is required. If a new piston pin falls through a dry rod pin bore as a result of its own weight, replace the rod.

Piston Pin Inspection

Replace the piston pin if it is cracked, scored, or out-of-round more than 0.002 inch (0.05mm).

Piston Clearance

The proper piston clearance is obtained when the piston and cylinder oversizes match. Measure the piston diameter at the location shown in Figure 9-24 and compare with the bore diameter of the cylinder to confirm that the oversizes match.



CT-1063

FIGURE 9-24. PISTON CLEARANCE MEASUREMENT

Piston Ring Gap

Before installing new rings on the piston, check the ring gap by placing each ring squarely in the cylinder (push in with the piston) at a position corresponding to the bottom of its travel (Figure 9-25). The gap between the ends of the ring is given in the Dimensions and Clearances section. The practice of filing ring ends is not recommended. Check again to see that the standard or oversize dimension being used for rings and cylinder bore match.

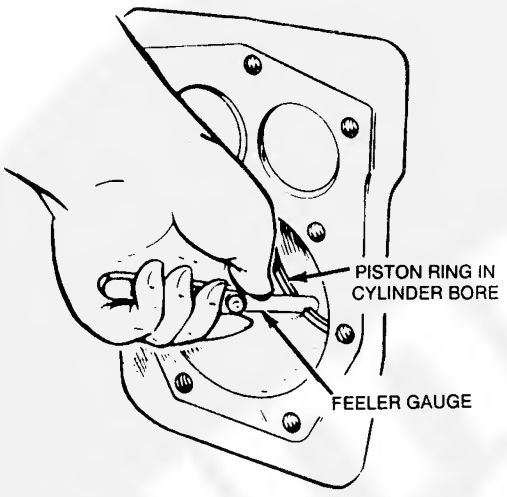


FIGURE 9-25. CHECKING RING GAP

Piston Assembly Installation

Lubricate all parts with clean oil. Line up the rod and piston pin bores and push in the piston pin. Snap in the lock ring at each end to retain the piston pin in the piston.

Install the piston rings. Start with the oil control ring and work up. Use a piston ring spreader to prevent twisting and over expansion. Compression rings are marked with a dot or the word "top" on the side that must face up. Space each gap one third of the way around from another gap.

Install the piston assembly as follows:

1. Turn the crankshaft until the rod journal is at the bottom of the stroke.
2. Lubricate the piston and cylinder and compress the rings with a ring compressor (Figure 9-26).

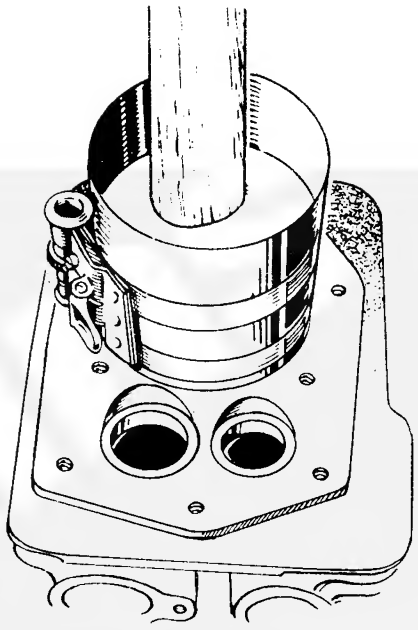


FIGURE 9-26. INSTALLING PISTON

3. Position the piston and rod assembly in the cylinder block with the oil hole in the rod journal end facing the camshaft side of the block. (Or, when the rod cap is on, the bolt heads face away from the camshaft when the rod is at the bottom of the stroke.)
4. Tap the piston down into the cylinder with the wood handle of a hammer until the rod seats on the rod journal.

5. Use Plasti-gage (green code) to check the journal clearance (Figure 9-27), as follows:

   A. Wipe oil off the rod cap and journal.

   B. Place a piece of Plasti-gage across the full width of the cap where it will be in line with the rod — not midway between the bolt holes.

   C. Attach the rod cap and torque the bolts as specified under Torque Specs. Note the raised marks on the rod and cap. These must be on the same side. Make sure the crankshaft does not turn, or the Plasti-gage will smear.

   D. Remove the cap and check the width of the flattened plasti-gage against the scale on the envelope.

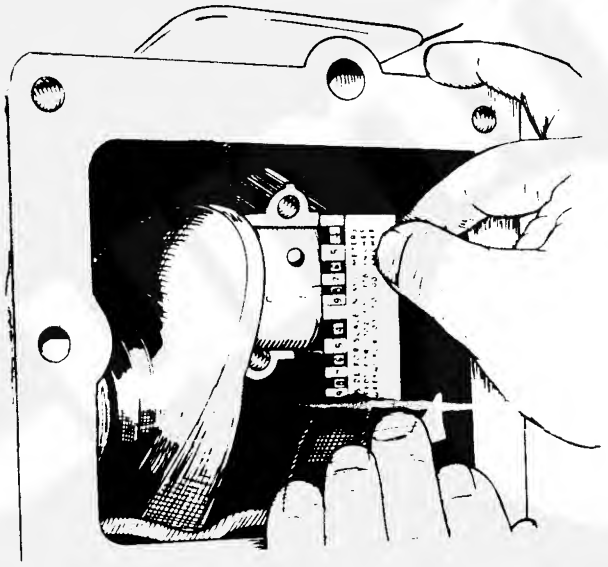


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FIGURE 9-27. MEASURING BEARING CLEARANCE WITH PLASTI-GAGE

6. Lubricate the rod journal and attach the cap again and torque as specified.

7. The rod should move freely from side-to-side between the shoulders of the rod journal. If it doesn't, loosen the cap bolts and tap the cap, and try again.

8. Crank the engine by hand to check that all bearings are free.


cummins

Section 10. Service Checklist

⚠WARNING

EXHAUST GAS IS DEADLY!

Exhaust gases contain carbon monoxide, an odorless and colorless gas. Carbon monoxide is poisonous and can cause unconsciousness and death. Symptoms of carbon monoxide poisoning can include:

- ***Dizziness***
- ***Nausea***
- ***Headache***
- ***Weakness and Sleepiness***
- ***Throbbing in Temples***
- ***Muscular Twitching***
- ***Vomiting***
- ***Inability to Think Coherently***

IF YOU OR ANYONE ELSE EXPERIENCE ANY OF THESE SYMPTOMS, GET OUT INTO THE FRESH AIR IMMEDIATELY. If symptoms persist, seek medical attention. Shut down the unit and do not operate until it has been inspected and repaired.

Never sleep in vehicle with the generator set running unless the vehicle interior is equipped with an operating carbon monoxide detector. Protection against carbon monoxide inhalation also includes proper exhaust system installation and visual and audible inspection of the complete exhaust system at the start of each generator set operation.

1-RV

GENERAL

After servicing, inspect and test the complete installation to confirm that the generator set will operate properly and will pull full rated load. Check each of the following areas before putting the set into service.

MOUNTING

Examine all mounting bolts and supporting members to verify that the generator set is properly mounted. All fasteners should be tightened securely to prevent them from working loose when subjected to vibration.

LUBRICATION

If the engine oil was drained, fill the crankcase with oil of the recommended classification and viscosity. Refer to the appropriate Operator's manual for the specific recommendations and procedures.

WIRING

Verify that all wiring connections are tight and hooked up properly. Check each of the following:

- Load Wires
- Control Wires
- Ground Strap
- Battery Cables

INITIAL START ADJUSTMENTS

Adjust the carburetor idle adjustment screw and main adjustment screw as specified in the Fuel System section to allow starting.

Start the set and immediately adjust the governor speed adjustment screw to obtain a safe no-load operating speed. With no load applied, listen for any unusual sounds or vibrations. When the choke is completely open, adjust the carburetor and governor as specified in the Fuel System section.

OUTPUT CHECK

Apply a full load to make sure the set will produce its full rated output. Use a load test panel to apply a progressively greater load until full load is reached.

EXHAUST SYSTEM

With the generator set operating, inspect the entire exhaust system including the muffler and exhaust pipe. Visually and audibly check for leaks at all connections, welds, gaskets, and joints and also make sure exhaust pipes are not heating surrounding areas excessively. If leaks or corroded areas are detected, shut the generator set down and correct immediately.

⚠WARNING ***Inhalation of exhaust gases can result in severe personal injury or death. Inspect exhaust system audibly and visually for leaks daily. Repair leaks immediately.***

FUEL SYSTEM

With the generator set operating, inspect the fuel supply line, filter, and fittings for leaks. Check any flexible sections for cuts, cracks and abrasions and make sure they are not rubbing against anything that could cause breakage.

⚠WARNING ***Leaking fuel will create a fire hazard which can result in severe personal injury or death if ignited. If leaks are detected, shut generator set down and correct leak immediately.***

CONTROL

Stop and start the generator set several times at the set control and remote control (if equipped) to verify the control functions properly.

MECHANICAL

Stop the generator set and inspect for leaking gaskets, loose fasteners, damaged components, or interference problems. Repair as required. Inspect the generator set compartment and verify there are no breaks or openings in the vapor-proof wall that separates the compartment from the coach interior. Seal openings as required.

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